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GAS JOURNAL

LIGHT ✦ HEAT ✦ POWER ✦ BYE-PRODUCTS

[Founded in 1849 as the "Journal of Gas Lighting."]

VOL. CLVI. No. 3055.] LONDON, NOVEMBER 30, 1921. [73RD YEAR. PRICE 1s.

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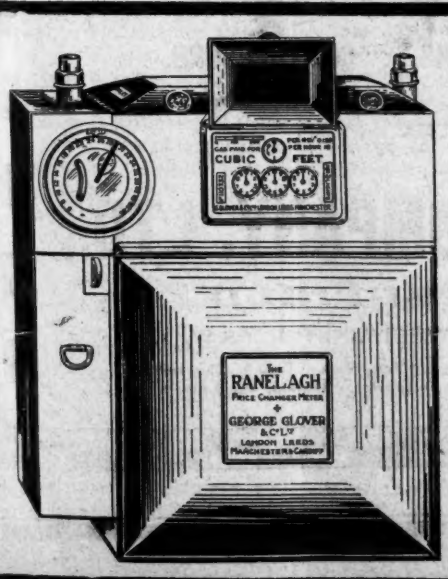

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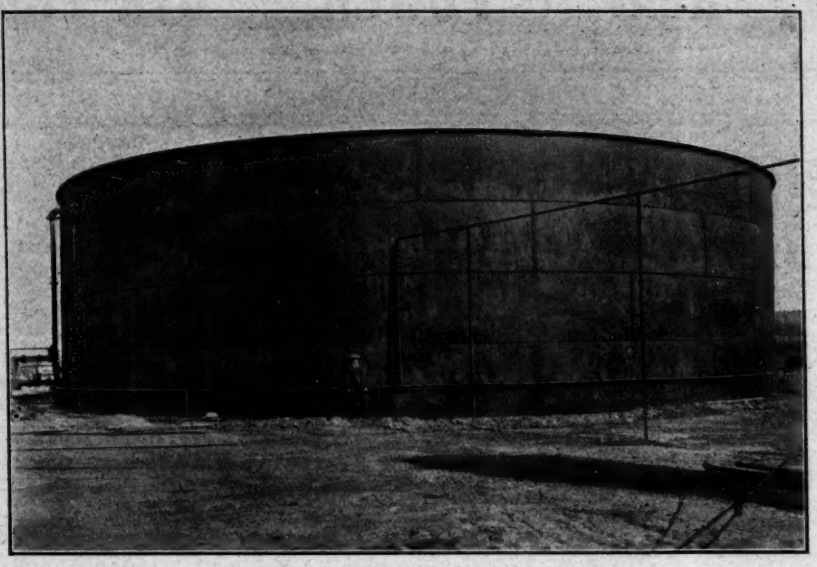

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EDITOR & PUBLISHER: WALTER KING. OFFICE: 11, BOLT COURT, FLEET ST., LONDON, E.C. 4.

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EDITORIAL NOTES.

On the Road.

THE Public Works, Roads, and Transport Congress, through the programme arranged for one of the sittings by the Institution of Gas Engineers, with the President (Mr. Thomas Hardie) in the chair, has brought into prominent notice how much the gas industry is interested in the public uses and the upkeep of our roadways. They have been very much regarded in the industry as public avenues to be lighted, and as the most convenient places in which gas-distribution systems could repose with more or less safety and comfort. But we can look upon the interest of the gas industry in the services of the roads from a much broader standpoint now than heretofore. The lighting of streets is an important part of the public work of the industry; but until competition compelled, the industry unfortunately paid little attention to the lighting of streets scientifically. The industry has lost heavily through the neglect. Before the war statutory gas undertakings had, combined, reached the highest peak numerically in public lamps supplied. The number was (excluding non-statutory areas) in the region of three-quarters of a million lamps. But by March of last year, the number had descended to 545,712. This is a very rapid decline; and it is not all due to competition. Some part of it is attributable to economy; many lamps discontinued during the war not having been restored to service through financial stress. Another cause is the displacement of small units of lighting by a less number of larger units. A third cause—and perhaps the greatest of all—is the municipal possession of electricity supply, which claims that street gas lighting should be superseded no matter at what cost, and no matter how much the scientific canons of lighting are violated—all for the purpose of increasing the business of the electricity undertakings. We see no reason, however, why the pendulum should not, with the application of common sense and scientific principles, swing back the other way where the competing lights and their respective virtues are allowed to have fair play, and are not dominated by the vested electrical interests of the local authorities. Public lighting, then, is one interest that the gas industry has in the public roads. A second interest is that it supplies a motor fuel for transport purposes. A third that its dehydrated coal tar is used so extensively for maintaining road surfaces and improving them for public use; and tar and pitch are largely employed in road construction. Further—and this the most important perhaps—it helps to save the surface of roadways by the subterranean distribution of gaseous fuel, thus reducing the passage over the road surfaces of the heavy vehicular traffic engaged in the distribution of coal. The use of gaseous fuel contributes to the amenities and the healthfulness of outdoor life by diminishing the pollution of the atmosphere by the smoky emanations of coal fires.

To revert to public lighting, had there been (as we have previously said) more science and common sense applied in times past to the treatment of public lighting by the gas industry, there would have been no genuine reason in places for a conversion to electricity. In competition where the neglect of sound principles by one side is the rule rather than the exception, this must result in loss to that side; and the foolish thing about the part of the loss of public lighting due to neglect and consequent dissatisfaction is that gas lighting, properly installed and maintained, complies better than any other illuminant with all the criteria that Dr. J. S. G. Thomas, on behalf of the Public Lighting Department of the South Metropolitan Gas Company, submitted at the congress were essential for efficiency in street lighting. These criteria are: The adequacy of the illumination provided; steadiness and constancy of the light sources; absence of glare; cost to be a minimum compatible with the provision of adequate service; and the system to be such that national fuel resources are conserved to the utmost. Now one has only to ponder over these criteria, to see how much nearer gas lighting can realize them all than any other means of illumination. But these virtues are subject to application in a scientific and not a haphazard way. "Science," however, does not consist of the application of high-sounding units of measurement or performance which are not easily defined, and are little appreciated by the practical man. "Illuminating engineering" will not and cannot live as a practical art if it has to be bolstered up by such units and appellations; and therefore we side with Dr. Thomas's condemnation of the complexity that is being introduced, and his appeal for more generally comprehensible units and practices. The best way to destroy this clap-trap nomenclature for units of hazy constitution is to boycott it, and persist in practice in the use of unit expressions that are most widely understood, and which adequately define. Quite sufficient for all purposes are the candle power of the light sources (providing reference is made to the angle at which the measurements are made, or are to be made under contract specifications), *plus* the measurement of the illumination at given points in order to secure uniformity of distribution. With regard to "glare," it might be said that in incandescent gas lighting relative to electric lamps it is absent. In view of the wide differences in lights in this respect, we maintain that efficiency should be defined as the amount of light that is usefully available after shade or other necessary corrections have been applied to deprive the light of injurious or distressing effects; and cost should be based on that corrected efficiency, for it is the only "efficiency" that is of intrinsic value to the user. As the paper says, the question of glare has become highly important during the last few years, owing to the use of unscreened gasfilled lamps. The higher the glare, too, the worse the distribution, and the deeper the shadows and the want of uniformity in lighting—both to be avoided as much as possible in the streets of urban areas. As to steadiness and consistency, there is nothing superior to a properly maintained inverted incandescent gas-lamp, providing there is a fairly uniform composition and pressure of the gas supplied; and, as Dr. Thomas points out, the Gas Regulation Act will doubtless assist in producing these contributory conditions to good gas lighting. The question of cost cannot be discussed in this reference. With both gas and electricity, matters are to-day abnormal in respect of expenditure for all purposes; but there is no question that gas offers the system that complies best with the demand for the conservation of our national fuel resources. The paper (published last week) is probably the best that we have ever had from the side of the gas industry dealing with the scientific aspects of public lighting, just as the South Metropolitan Gas Company's area supplies one of the best examples of public lighting in the country.

There is the contribution that the gas industry has made and is making to the supply of motor fuel for road traction purposes. The subject of benzole was well treated in the paper by Captain de Normanville. Users have by experience learned of the merits of benzole; and they know that it possesses certain disadvantages, if not properly treated. Benzole does not stand alone in this respect. The disadvantages, however, become bogies in the hands of the gallant captain, when he shows how easy it is to avoid them. The main advantage of benzole is its higher concentration of

thermal energy than petrol possesses per gallon, which represents some 20 p.ct. more power and therefore mileage. There are also collateral advantages which have their value. But with the increase in the popularity of benzole, there has been a decrease in its production, owing to two causes—the rapid fall in industrial activity through which many bye-product plants are closed-down, and the fact that, at to-day's relative prices for gas and motor spirit, the therm value to gas undertakings of benzole is greater in gas than when extracted for motor purposes. We cannot at the moment vision the developments or changes of the future; but the time may come, when therm prices are further reduced, and more of the coal now used in fire-grates will pass through carbonizing or gasification plants, and still lower concentrations of thermal energy will be supplied in gas. Then the gas industry may return to benzole washing as a common practice, if there is greater profit in it than its therm value as gas.

The use of tar for road making and maintenance purposes has increased enormously, which shows the appreciation of its virtues for the purposes. Time and extension of application have brought a large experience to bear on the subject; and it is now clear that some amendment is required in the specifications for tar for road work. In the paper by Mr. H. W. James, Manager of the tar works of the South Metropolitan Gas Company (which is reported with the discussion this week), he made a plea for greater elasticity in the specifications, and for simplification of the tests. And a good case he presented in indicating where improvement and simplification are necessary. The difficulty in framing specifications to suit all circumstances is that tar is produced under different conditions in relation to plant and temperatures, and from coals varying in physical and chemical characteristics; and thus there come about considerable variations in the constitution of tars. These make it impossible to draw-up specifications applicable to the whole, and therefore a compromise was effected in them in order to admit as wide a range as is practically possible. There are numerous points in the paper, which will be studied with interest by tar distillers and those users who are capable of interesting themselves in the constitution of a substance of such proved value in their work. From the many points, we may just refer to one or two as examples. In the question of free carbon in tar, some years ago we took great interest. It was then the fashion to regard and speak of this as a deleterious constituent, which for road-making purposes should be kept well within bounds. The practical experience of years has brought a change. In Mr. James's paper we have a defence of free carbon as a valuable property of tar for road work; and this is confirmed by practical users. In tar, it serves a useful purpose; in pitch, it has the power of rendering the product tougher and so less brittle. The upper limit in the present specifications is too low—in fact, tars that are deficient in insoluble compounds have proved very unsatisfactory. The difficulty, however, is to discover the limit beyond which the insoluble constituents in tar become a disadvantage. Constitution enters very largely into the determination. There is also the question of the degree of "cutting-back"—that is, the addition of tar oils for reducing the hardness of pitch or the consistency of tar, in which process care has to be taken not to precipitate the insolubles. From Mr. James's premises, it is fairly obvious that the higher the distilling points and the specific gravities of the oils used for cutting-back, the less tendency will there be for insoluble matter being thrown out of suspension, and therefore the better will be the product obtained. These are only two of several matters dealt with in this valuable paper, which shows that the requirements in a tar for road purposes have become much better appreciated.

In the final paper, Dr. J. S. Owens dealt with the effects of the use of gaseous fuel in reducing the pollution of the atmosphere caused by the combustion of solid fuels. This is a question that one cannot completely judge by comparison data, because of their deficiency. As the years pass, in some areas the population increases, and becomes more dense; and though the use of gas appliances increases, there is probably a set-off by the coal fires brought into use by the new residents. One would like to be able to ascertain the reduction or increase in the quantity of coal sold in a given district over a given number of years, and to set this in contrast with the rise in the quantity of day gas sold in the same area. But the statistical evidence advanced by Dr. Owens proves that, with the increased use of gas appliances, there is a reduction of atmospheric pollution and organic deposits; but what would have been the amount of these (say) in London north of the Thames alone if the million-and-a-half of gas appliances on the records of the Gas Light and Coke Company, without the privately owned ones, had not been in use? The educative work of smoke abolitionists will no doubt effect much towards the end they have in view; but we believe that hitherto the progress in use of gas-consuming appliances has been due more to convenience and labour-saving than to any real persuasion as to making a contribution to greater atmospheric sanitation. The work, however, is having good effect among local authorities, as Mr. F. W. Goodenough pointed out in the discussion. The Becontree Estate, with the 3000 houses now being constructed by the London County Council, will be almost free of home-produced smoke through the provision that is being made for utilizing gas. As to the saving of cartage of coal along the roads and labour in the delivery, Mr. Thomas Goulden calculates that some 2 million tons of coal less are used per annum in London and the immediate suburbs owing to the use of gas heating.

The paper by Dr. Owens concluded the very practical batch of contributions, which show us something as to the varied part the gas industry has in improving the conditions and conveniences of our roads, as well as the atmosphere in which we move and have our being.

Therm Price Reductions.

OUR news pages the last two or three weeks have been showing the first stages of a very satisfactory movement. Here and there the therm prices that have been charged since Orders under section 1 of the Gas Regulation Act came into operation are being reduced by 1d. or so up to 2d., which per penny represents in most cases 4½d. to 5d. per 1000 c.ft. The reductions that have been made—by the Gas Light Company, the Commercial Company, the Brentford, Sheffield, Dublin, and Croydon Companies, and there may be others which at the moment have escaped memory—will aggregate a considerable sum of less expenditure by the consumers. The ability to begin on the downward trend of prices is remarkable so soon after the terribly heavy expense into which the three months' coal strike landed gas undertakings. The reductions are an earnest of the desire of directors of gas companies to share as quickly as possible with the consumers any advantages that changed conditions confer, and to restore to former levels the fallen incomes of the share and stock holders and the values of their holdings. The ability to reduce prices is the product of, first, the improved position in coal prices, though these are much above what they ought to be if coal production per man was at the best standards of pre-war years; secondly, the reduction of oil prices; and, thirdly, the removal of the peaks from wage payments. Discounting these advantages are the lower market values of secondary products, and the poor demand for certain of them. However, this beginning of the lowering of prices will be heartily welcomed by consumers, as by the share and stock holders. Gas is daily becoming a more popular fuel, because of its convenience and the saving that it effects in household labour, and in industry because of its effects in works and output economy. No gas undertaking desires that this flow of popularity shall be stemmed by any unnecessary rate of charge per therm; but rather that business shall be promoted by lowering the price at every opportunity. Every step this way is a step to greater stability, and to giving to gas shares and stocks that return which will move them to a position more attractive to investors than they have been the last few years. Every gain in this direction also improves the situation of gas undertakings in making new issues of capital. There are plenty of factors urging therm price reductions as rapidly as reason and prudence will allow.

Heat Values and Chemical Compositions of Gas.

IN addition to their bearing upon the theory of gaseous combustion, there is a melancholy interest attaching to the results of the investigations described in the paper on "Gaseous Combustion at High Pressures," which Prof. W. A. Bone and (the late) Mr. William Arthur Haward, M.Sc., communicated to the Royal Society, and which communication we have obtained permission to reprint. It was while actually engaged in Prof. Bone's laboratory upon some final experiments designed to test and develop certain of the theoretical issues set forth that Mr. Haward met

his untimely death. The valuable work has not yet been finished. But the results are presented so far as the research has gone; and it has now to be completed by others. This one piece of research shows the loss of a talented and enthusiastic investigator. We cannot discuss a paper which is a record of exploration directed to penetrating matters not hitherto satisfactorily established. However, issuing from the investigation is a point of practical interest, which is referred to towards the end of the paper. It is frequently assumed that the relative values of different combustible gases in a mixture are strictly proportional to their heats of combustion, irrespective of their chemical characters or modes of combustion. The authors submit that it seems difficult to reconcile this with the cumulative results of the last forty years of scientific research upon gaseous combustion, which have shown more and more clearly that the fundamental properties of the explosive mixtures formed by different combustible gases with air, arising from their own peculiar chemical characters and compositions, do affect profoundly their economic uses. It is added that the present research emphasizes the importance of the chemical composition of a combustible gas (or mixture) as a factor not to be disregarded when its economic value is in question.

Sulphate of Ammonia Position and Organized Operations.

TAKEN in conjunction, the report of the British Sulphate of Ammonia Federation, Ltd., published last week, and the account of the speech of the Chairman (Mr. D. Milne Watson) given this week, form extremely interesting reading. In every part, they confirm the major view among sulphate of ammonia makers that an organization is essential for propaganda work, for getting into and keeping in close touch with the consumers both at home and abroad, for demonstrating to them the virtues of sulphate of ammonia, for entering into mutually beneficial business arrangements with them, for raising the qualitative standard of production, for marketing and distributing output in all parts of the world, and for dealing with the swelling competition from the different sources of, and processes for producing, nitrogenous fertilizers. It is also abundantly clear from the report and speech that those makers who prefer to pursue an individual course (makers representing only 10 p.ct. of the British make) are benefiting in good measure from the activities and influences arising from organization and collective action. No individual makers could do what the Federation are doing and accomplishing, though some makers—guided more by old political and economic theories and formulæ than by expediency necessitated by new times and conditions—may not agree with all the lines of policy of the Federation. But bye-product sulphate of ammonia is in a peculiar position. It is being assailed by a combination of unprecedented circumstances; and such circumstances require concerted procedure, care, diplomacy, and action, some of which would not perhaps be necessary if the production of nitrogenous fertilizers had common source and manufacturing process. But they have not; and so their commercial advantages vary in relation to their respective costs of production—including all charges. With so many sources of production—particularly that of the nitrogen of the atmosphere—it is imperative that the most effective means of creating and maintaining business should be adopted; and this some 400 makers, representing about 90 p.ct. of bye-product sulphate, assert is through the Federation. The accuracy of such a verdict, with the circumstances before us, we cannot dispute.

The report and the speech of the Chairman of the Federation are optimistic to a degree. Whether existing circumstances justify such optimism, it is difficult to say. At any rate, the optimism shows a strong faith in the power of combined operation and in the methods applied by the Federation; and the prices charged to-day for bye-product sulphate, which render it the cheapest form of ammonia available, certify that no advantage is being taken of the consumers. Naturally, the Federation have to trim their sails to the wind. Nitrogen in stock at this time is unpleasantly plentiful—more than the world can promptly absorb. In view of this, and the known developments to increase the production of synthetic ammonia, the policy the Federation has pursued in making drastic cuts in sulphate prices has given to them the advantage that Mr. Milne Watson pointed out. The general position of the bye-product commodity, he said, has vastly improved, compared with what it was at the end of May, for the price reductions have enabled the liquidation of all stocks, and there are orders on the books of the Federation for a substantial portion of future production. This is a healthy and satisfactory position. It was worth some considerable sacrifice (if so it can be called) when available supplies from other quarters were so plethoric as to be beyond the power of absorption. Had the Federation not voluntarily reduced prices, they would have been knocked-down by the pressure of inflated stocks of nitrogenous fertilizers—nitrate especially. It is reassuring to learn from the Chairman of the Federation that there is no reason at present why the position should not be maintained during the current year; but one cannot, in respect of sulphate, speak far forward. There is good ground for the Chairman's belief in relation to the immediate future. The Federation are in touch with their agencies away to the uttermost parts of the earth; and at home the organization of the Federation has been so improved that it is in closer touch with consumers than ever before. Some remarkable figures appear in the report which show the value of what has been and is being done. Last year, of the Federation production 57 p.ct. was absorbed by the home markets, as against only 11 p.ct. before the war. During the war, markets were lost abroad equal to some 90,000 tons; but this loss has been more than counterbalanced by the 167,000 tons consumed at home, 125,000 tons of which represent new markets. The problem now is how to maintain this satisfactory condition of things, and how to extend the home demand still farther. In this connection, we have to remember the Billingham and the Cumberland ventures now in process of development, which will bring on to the market home-produced synthetic compounds for fertilizing purposes. The Federation, however, have all these matters well in hand, and in regard to them are pursuing a policy that is indispensable to the makers. The position requires scrupulous watching, which can only be given by a complete organization, having the means of obtaining first-hand information, such as the Federation possess.

The Federation have also been taking part in international conferences, having in view the competition of synthetic ammonia. They have done wisely. The conferences have led to better understandings of the position, though not to agreements for the regulation of production and distribution of the several forms of nitrogenous fertilizers. Mr. Milne Watson warns that there must be no illusion as to what can be done; and, for sustaining the position of bye-product sulphate, there must primarily be reliance upon propaganda and the powers of the makers to meet competition and to secure their position. The regulation of supplies by agreement (if it could be effected) may be altogether opposed to the political and economic creeds of some; but political and economic theories and principles have at times to give way to expediency. This is one of those times. It is no use producing, if there is no profit attaching to the sale of a product. Therefore, if agreement between makers as to the regulation of production will result in reasonable profit being made by them all without distinction, there can be no valid objection on the part of consumers. If one set of makers, synthetic or otherwise, can produce so cheaply that they can exterminate all manufacturers working other processes, then eventually they would become the masters of the situation, and price would be subject to their will acting in combination, and not subject to the law of supply and demand. This consumers cannot desire. The capacity to produce has become so enlarged, and the facility with which that capacity can be extended through the extraction of nitrogen from the atmosphere is so great, that there can be no question in future that high prices will again obtain; and the maintenance in trading existence of producers by the various processes is the best assurance consumers can have that they will not hereafter be subject to price decisions solely made by producers by any single form of process. If eventually, having in view the extraction of nitrogen from the atmosphere, there is success in realizing an agreement to regulate production, there will be advantage without injury to anyone, and no question of the extermination of any of the producers.

Transport Charges for Coal.

It was an extremely interesting case that the Mining Association recently placed before the Railway Clearing House for relief to the trading community in respect of railway rates for the carriage of coal. They believe a substantial reduction in rail-

way rates and dock charges should be made, in order to help to stimulate a revival of trade and a larger demand for coal, which would benefit the railway companies, as well as the coal industry. The output of coal was in 1913 287 million tons; in 1920, 229 million tons; and at the present rate of output, 205 million tons, or a reduction of 82 millions compared with 1913. There has been a reduction of 43 million tons (or 25 p.ct.) in the consumption by industries, and of 39 million tons (or over 40 p.ct.) in shipments for export and bunkering. There has also been a diminution in the shipments of coke compared with 1913 at the rate of 800,000 tons per annum, or 65 p.ct.; and of patent fuel at the rate of 600,000 tons, or 30 p.ct. These figures are based on September this year. Nearly all the coke-ovens are idle at the present time, and the current make of metallurgical coke is only at the rate of about 2,480,000 tons, as compared with 12,700,000 tons in 1913. The transport charges, particularly on low-grade fuels, are prohibitive; and unless these fuels are disposed of, colliery operations cannot continue. The average increase in railway charges on coal is said to be about 3s. 6d. per ton. In their pleading for consideration, the Mining Association further pointed to the effects of these charges on industry and trade generally. It was a good case; and the gas industry, among others, hopes it will be effectual in winning a concession.

Incombustibles in Coal.

The question of the use of Forks *v.* Shovels for tub-filling in mines has become acute in Leicestershire. The owners are evidently fully determined to do all they can to get honest coal, instead of a large proportion of dirt. It is understood that the Leicestershire Miners' Council have decided to take a ballot of the miners this week on the demand of the owners for a reversion to fork work. Some 8000 miners are under notice to cease work early in December unless forks are again used. It is not anticipated, however, that there will be another stoppage, inasmuch as forks are already in use in Derbyshire, Nottinghamshire, and other districts.

Works Committees and Management.

Shop stewards and works committees are all right so long as they keep to their legitimate functions. But when they use their positions to get a larger grip over control, an intolerable situation may be created. In the engineering industry, the Amalgamated Engineering Union has been increasing its efforts practically to get, through the shop stewards and works committees, control of the industry by insisting that before certain legitimate functions of management are exercised by employers or their representatives, there shall be consultations with the shop stewards or works committees. This the employers could not stand. There have been conferences, and at one time it appeared likely there would be a rupture over the matter. Happily, it has been settled (subject to the approval of the men and the employers' associations) in terms which provide that the trade union are not to interfere with the right of the employers to exercise managerial functions in their establishments, and the Employers' Federation are not to interfere with the proper functions of the trade union. In the exercise of these functions, the parties are to have regard to the Provisions for Avoiding Disputes of April 17, 1914, which are amplified by the Shop Stewards and Works Committee Agreement of May 20, 1919, and to the terms of other national and local agreements between the parties. Instructions of the management are to be observed, pending any question in connection therewith being discussed in accordance with the provisions referred to. It has also been agreed that in terms of the Overtime and Night-shift Agreement of Sept. 29 and 30, 1920, the employers have the right to decide when overtime is necessary; the workpeople or their representatives being entitled to bring forward, under the provisions referred to, any cases of overtime they desire discussed. Meantime the overtime required is to be proceeded with.

Loans for Creating Employment.

There has been a good deal of speculation as to what is the exact position regarding loans under the Trade Facilities Act. According to a statement issued by the Advisory Committee, the Treasury is empowered to guarantee the principal and (or) interest on loans up to a total of £25,000,000, the proceeds of which are to promote employment. The loans to be guaranteed must be raised to finance capital undertakings. The Advisory Committee want to make the best allocation possible of the limited facilities; and so they desire to have quickly for review all the schemes prior to making a final selection. Intending applicants should therefore submit preliminary applications as early as possible. Before approval is given, the Committee will wish to be satisfied that the undertaking or scheme cannot reasonably be financed without State assistance, and that it is of such a nature as to reduce unemployment in the United Kingdom. Gas undertakings ought to stand well in this matter, seeing that among the considerations for preference are these: Applications under which securities can be readily issued to the public; applications to which the minimum of risk attaches. Those who want detailed information should apply to the Secretary, Trade Facilities Act Advisory Committee, No. 7, Whitehall Gardens, London, S.W.

Gas Coal Position.

Heavy fogs and colder weather, together with the approach of the Christmas holidays, have caused in most of the coalfields somewhat more activity in respect of gas coals. It is reported fairly generally that stronger inquiries are being made, and quite good supplies are going into gas-works. Durham and Nottinghamshire appear to be the fields which are weakest in the business that is being done, and in these areas there seems a good amount of gas coal available. From Yorkshire it is learned that the larger gas-works are freely buying screened classes of coal in the open market—not under contract. In Durham and Scotland, prices still show a downward tendency, though not to any marked extent, compared with immediately preceding weeks. In the North, the demand for coke is particularly strong for export purposes; prices are being maintained, and the bookings forward are heavy.

OBITUARY.

THOMAS DUXBURY.

We are sorry to have to record the death last Saturday of Mr. Thomas Duxbury, J.P., ex-Mayor of Darwen, who had for very many years been connected with the gas industry and with the public life of the town generally. Readers will recall that Mr. Duxbury, who was 75 years of age, was present last month at the East Greenwich works of the South Metropolitan Gas Company, on the occasion of the visit of the Institution of Gas Engineers, and that he did not appear then to be in the best of health.

A member of a very old local family, Mr. Duxbury began his public career over half-a-century ago, being appointed in 1866 Assistant Secretary and Manager of the Darwen Water-Works Company. Four years later, he became Secretary and Manager, which position he held until the gas and water undertakings were acquired by the Local Board in 1872, when he was appointed Secretary to the Accrington Gas and Water Company. Until 1877 he remained at Accrington, and then returned to Darwen to take up the position of Engineer and Manager of the Corporation Gas and Water Works. He remained Gas Engineer and Manager until 1895, when he resigned, in order to set up in business in Manchester as a coal factor and gas engineer. During his *régime* important extensions of the gas-works were carried out; and the price of gas was reduced 1s. 6d. per 1000 c.ft. for lighting, and 2s. 3d. for cooking, heating, &c. Among the positions he occupied in connection with the gas industry was that of Chairman of the Leyland Gas Company.

He was invited in 1919 to become Mayor of Darwen; but a serious illness had left him at the time in such poor health that he had to decline the offer. Subsequently, however, there was some improvement in this respect; and, under pressure, he accepted the Mayoralty last year. During the many years spent in the Town Council, he has been extremely active on gas matters; and past volumes of the "JOURNAL" contain several strong protests by him against the practice, more popular formerly than it is now, of appropriating large sums from gas profits in relief of the rates.

The deceased gentleman was an honorary member of the Institution of Gas Engineers, an associate member of the Institution of Civil Engineers, a Past-President of the Manchester District Institution of Gas Engineers, and a fellow of the Chemical Society. Older members of the profession will remember the active part he took in the proceedings which resulted in the re-organization and incorporation of the old Gas Institute.

Mr. Duxbury had two sons. The elder one—Mr. Thomas Hindle Duxbury, who died in November, 1918, was Engineer and General Manager of the South Shields Gas Company; while the younger one joined in business with his father. There was a service yesterday [Tuesday] at the Duckworth Street Congregational Chapel, Darwen, followed by interment in Darwen Cemetery.

TAR DISTILLATION.

By HAROLD E. COPP, of Hull.

A Contribution to the Discussion on the Paper by the Society of British Gas Industries on Tar and Sulphate, read at the Recent Meeting of the Institution of Gas Engineers.

SECTION A.—TAR DISTILLATION.

Having had considerable experience with tar dehydrating apparatus of the coil type, I have found it to be very satisfactory within certain limits; but if the tar is dehydrated at a sufficiently high temperature to conform to the Road Board's specification, there is considerable risk of the burning-out of coils. Moreover, the tar is extremely viscous and, therefore, difficult to handle unless kept warm. This, of course, entails a constant expenditure of heat, either directly applied to the storage tanks or in the form of a steam-heating coil. The only alternative is to dehydrate at a still higher temperature, and to lower the viscosity of the product by the addition and mixture of tar-oils. This, I think, is the better course, as tar treated in such a manner is the more satisfactory for road purposes.

A coil-still is not to be recommended for the rectification of wash-oils used for benzole and naphthalene extraction, as the oils are frequently more or less emulsified—causing a stoppage of the feed-pump, and consequent burning-out of coils. Generally speaking, gravity feed from a fairly large tank will be found preferable to, and more reliable than, a pump.

It is stated that one man can attend to a plant for the complete distillation of 40 tons of crude tar per day; but we are not informed as to whether the process is continuous. If not, it is difficult to see how the plant is managed. Presumably, the dehydrating process is continuous, so that the pot-stills may be filled in rotation. If this be so, one man would not attend to the plant alone during the night. Having recently considered the installation of a continuous plant, I found that the labour costs would be at least trebled. I therefore decided to renew the five pot-stills, and to add three double-coiled heat exchangers, with additional condensers to each.

The working of such a plant will not involve any further labour costs. It is hoped that a dehydrated tar of suitable quality for road purposes will be produced by passing the distillates from one pot-still through the heat-exchanger. If, however, this is not found to be practicable, part of the products from another still will also be passed through the vessel; so ensuring that its contents are heated to a suitable temperature for a sufficient length of time.

The continuous process possesses many attractions; but it should be observed that very few of the large tar distillers have adopted it, and generally use pot-stills. Continuous processes would, on most gas-works, require three shifts of at least two men; so that it would only pay the largest of works to adopt this system. Moreover, capital costs form an item which is often lost sight of.

Pot-stills not only burn-out on account of the action of direct heat on the bottom, but also show great erosion on the inner surface of the plates at the boiling level. The former objection may be provided for by having the stills so constructed that the bottom may be entirely renewed without removing the still from its setting; whereas the latter may be almost entirely obviated by putting a dehydrated coil or heat-exchanger in series with the still.

Pot-stills may be kept perfectly clean by introducing a fresh charge of crude tar at the precise moment that the last of the pitch from the previous distillation is leaving the still. Every three distillations, it is also advisable to precede the introduction of tar with a small quantity of anthracene oil. By following this practice, stills never require scaling, and may be kept clean during their whole working life.

As to the heating of continuous stills by gas, although this may be a paying proposition where coke-oven gas is available, after careful consideration I am firmly convinced that it cannot be done economically on a gas-works under present conditions, even with blue water gas.

SECTION B.—SULPHATE MANUFACTURE.

It is noticeable that all the plants described (though embodying no important new principles) aim at producing sulphate of a higher quality than that with which we were formerly satisfied. This, in itself, is a very satisfactory feature of the paper; for we can only hope to retain our place in the markets of the world by producing a quality of salt which will compare favourably with that of our most scientific competitors.

Most of the existing forms of still are liable to choke, owing to the introduction of milk-of-lime into a chamber about half-way down from the liquor inlet. This trouble may be generally obviated by the use of a separate liming vessel; so that an old pattern still, which may be difficult to clean, can be made into quite an effective apparatus by the provision of such a vessel. It is always a good plan to allow some of the spent liquor to run into the lime-mixing apparatus, as thereby any ammonia which may be contained in the spent liquor can be immediately detected.

From the appearance of the sulphate produced at the South Metropolitan Gas-Works, which was so favourably commented upon by the members of the Institution during their recent visit to the East Greenwich Gas-Works, it would seem that the plant in use there fulfils all the conditions necessary to the production of sulphate of the highest quality. At Hull, a condenser was fitted for liquefying a portion of the ammonia passing to the saturator, for the purpose of spraying in the centrifugal machine for neutralizing the salt; but the process was abandoned owing to the discoloration caused by pyridine compounds. From the paper, it appears that the ammonia gas should be taken from a point half-way down the still, as by so doing discoloration will be avoided.

Personally, I do not consider that the centrifugal system of drying sulphate is ideal, as various parts of the apparatus are adversely affected by acid. Moreover, the method of spraying the inside of the centrifugal basket with weak liquor for neutralizing is very crude. I think that the ideal method will be found to be on the lines described by Messrs. R. & J. Dempster, Ltd.—namely, that of placing the drained salt into a separate vessel, first spraying with ammonia, and subsequently driving or forcing through the salt heated air for drying purposes. A mechanical agitator for the salt would facilitate the process; and it will be interesting to observe the results of the working of the revolving drying table referred to by the Chemical Engineering Company, and also the behaviour in practice of archimedean screw conveyors for neutralizing and drying the salt.

One of the great troubles in connection with a sulphate plant is the disposal of the spent liquor, and its separation from the spent lime. It will be found a great advantage periodically to pump (by means of a sludge-pump) the settled lime from the bottom of the separating tanks into an elevated tank fitted with a breeze or broken-brick filter, which allows the liquid to drain-away with the effluent, and at the same time permits the lime to be more or less solidified, so that it may be carted away and deposited in a convenient position. Evaporation may be accelerated by passing the hot spent liquor from the stills through suitable conduits placed under the sludge receptacle.

SIXTY YEARS AGO.

[From the "Journal" for November, 1861.]

"Flintoff is Coming."—If we may judge from the reports in the Scotch papers, the cry of "Flintoff is Coming!" creates as much sensation in the towns far north as the cry of the "Campbells are Coming!" did in the beleagured garrison of Lucknow. At Alyth, Blairgowrie, Forfar, and several other places, the cry has been raised, and, in some of them, the gas companies have surrendered at the sound, and lowered their standards—of price. We have no sympathy for gas companies who can be thus frightened into making reductions in their charges, nor, on the other hand, with such as require the constraint of fear before they make such reductions as their condition enables them fairly to do. It must be admitted that some of the towns in the North of Scotland present fruitful fields for Mr. Flintoff's labours. Such prices as 10s. and 8s. 4d. per 1000 c.ft. afford ample work for his pruning-knife, and give him fair opportunity for contrasting the price at which gas can be manufactured with the price at which it is sold. At Blairgowrie, one of the Directors of the Gas Company ventured to reply to Mr. Flintoff's assertions; and the personal abuse with which he was assailed by the lecturer may serve as a caution against entering the arena of controversy with such an antagonist. It is not pleasant, in a public meeting, to be charged with "want of brains," with "incompetency," and with being "so raw as not to know what to do with the raw material." Yet these were only a few of the personalities to which the Director was subjected; and they were, indeed, too strong to be relished even by the audience Mr. Flintoff had collected together. It may be that the indulgence in strong expressions tends to diminish his success, for he does not reap such a harvest as he might be expected to do in the North. Though fortune smiles upon him at the commencement of his labours, he somehow ends by achieving nothing; and the reputation he leaves behind him falls far short of his heralded renown.

Sugg's Argand Burner.—The reports we have from time to time published of the "gas examiners" appointed under the Metropolis Gas Act, have alluded to the differences which they have remarked in their experiments between the illuminating power of gas as determined in their own laboratories, and at the testing-places provided in accordance with the Act, and have justly attributed them to the superiority of the burners used at the latter places over those with which they have operated; though none of them has alleged that the burners provided by the companies did not strictly comply with the Act. Dr. R. D. Thompson, the "gas examiner" of the Parish of St. Marylebone, suggests, however, that he should have the power of selecting the burners, as "his experiments showed a difference of 2 candles between the burner he used and the burner used at the testing-station of the Company." Dr. Thompson can scarcely have been aware, when he made this suggestion, that the Act specially provided that the burner should be furnished by the Company, as a protection against the use of badly-constructed burners; and if he and the other Metropolitan gas examiners will each invest 5s. 6d. in one of Mr. William Sugg's well-made fifteen-hole argands, they will henceforward save themselves much trouble, and entitle their reports to more respect than has hitherto been accorded to them.

"MODERN GAS-WORKS PRACTICE."

EVERY gas engineer will find a friend in Alwyne Meade's second edition of "Modern Gas-Works Practice,"* which has just made its appearance. In comparing the first edition with the second, it is not difficult to trace the progress which has been made in the art of gas making, even in the comparatively short time since the first edition appeared in 1916. All the new features are embraced in the recent publication; and many of the old features are more thoroughly dealt with, and brought quite up-to-date. The modern "therm," which the general public are still struggling to understand, takes the position of importance as the basis of final comparison in all calculations regarding efficiency.

New chapters included are the much-discussed subject of the "Complete Gasification of Coal," the "Measurement of High-Temperatures in Gas-Works," and the highly important matter of "Naphthalene in Coal Gas"—the last named, in the original edition, being included in the chapter dealing with condensation. The chapter on "Naphthalene in Coal Gas" deserves special notice, because the author has been at pains to collate the various means and appliances by which this veritable "nuisance" can be mitigated or entirely removed. When anything becomes a "nuisance," and methods are known by which the "nuisance" can be entirely removed, the best thing to do is to put these methods into practice as soon as ever possible. Naphthalene has been a "nuisance" on works and district ever since gas was first supplied. It is high time its reign was ended. Let loose, it invades the works and the whole of the system of distribution, right up to the point of consumption.

There is not perhaps a more deadly enemy than naphthalene operating against the creditor side of any balance-sheet. After all, the balance-sheet is the best guide to the success of any undertaking; and here is a chance to effect a great improvement in it. While other important matters have been threshed out, the naphthalene weed still flourishes. Of all the methods the author notices, the most commendable one appears to be that practised by the South Metropolitan Gas Company, of scrubbing all the gas with anthracene oil. As the author remarks: "The process is remarkably effective, showing an efficiency of 100 p.ct., with but the barest trace of naphthalene in the finished gas, and frequently no trace whatever." If the words: "The process amounts to revivification," convey the meaning that the light oils extracted by the process are re-established in the gas, the process should command wide attention, because here appears to be a means whereby, with a reserve of light oils free of naphthalene, the thermal value of the gas can be maintained at a constant level, and many irregularities due to material and working can be overcome. As many works are fitted with oil-washing and benzole recovery plants, and as the author points out the recovery *per se* is the reverse of a remunerative operation at the present moment, it leaves these plants free to effect a much-needed reform. It is policy for any gas undertaking to save its consumers from annoyance, let alone put a good deal of money in its pocket by less payment for labour and office work, and through the sale of extra gas.

The chapters on the different retorting systems, including that of coke-ovens, are very engrossing, and give to the designer of new plant the opportunity of studying every known system of note, as ideas may be gathered from any system and incorporated, if desirable, in the new design. An excellent feature of these chapters—and, in fact, all through the work—is that the author not only tells how the plant should be properly worked, but also points out how to avoid or overcome difficulties and dangers.

Greater consideration needs to be given to the designing of furnaces under retorts of all descriptions. Mr. Meade says: "The economical operation of the modern regenerator depends, perhaps, more upon its structural features than upon any refinements in its working which may subsequently be introduced. . . . . The main point to be kept in view is the most effectual means for abstracting the maximum quantity of heat from the fuel." A glance at the analysis sheets of various important gas undertakings reveals that ideas as to furnace designing must be very diverse, judging from the tremendous differences they show regarding the percentages of carbon used for fuel and the consequent large differences in the sales of coke and breeze per ton of coal carbonized. Some undertakings appear to use nearly three times as much fuel as others; and, as may be expected, in most instances the lower the fuel percentage is, so the make of gas per ton of coal compares more favourably. It would mean a good many thousands of pounds sterling per annum extra on sales of coke in many instances. It would seem, judging from results, that those undertakings which have had recourse to the semi-external producer have achieved the best results. As may be expected, such a good thing is not forgotten by the author.

The chapter on the "Preliminary Purification of Coal Gas" will be food for reflection in choosing new plant. It is very complete; but there is one small matter which becomes of importance in practice that the author might have put into greater prominence, that is, the matter of having the tower-scrubber filled with wood grids, properly fashioned, as an improvement over board-filling. Wood grids, if made of square bars superimposingly crossed at right angles, and properly spaced, never cause blockage, and moreover create no measurable back-pressure; while at the same time they present a very large surface to the gas, ensuring efficient results. The cheaper the wood, and the rougher it is sawn, so much the better. Board-filling has an unhappy knack of blocking, with its attendant evils. May the author pardon this suggestion for an addition in a future edition, to what is already an absorbing section.

The chapter on the "Complete Gasification of Coal" is most interesting, and is no doubt exercising the minds of many of those in charge of gas undertakings, considering the progress which has been made in this form of gas making of late years. As Mr. Meade points out, it is not novel in principle, but, with present-day science and skill, is likely to be heard more of now that the "therm" has apparently come to stay.

Whether the public will ever really grasp what a "therm" is, time will show; but it seems a slow process, judging from lay conversations. It remains to be proved whether the term "therm" should not have been substituted by the term "unit," which is one the public have got used to, and especially as the chief opponent of gas is electricity. If a "unit" of 10,000 B.Th.U. had been adopted, it would have been at present at a cost of about 1½d.—nicely comparable with a unit of electricity at several times this cost, probably capable of much less work.

In conclusion, Mr. Meade's work may be said to be a concatenation of such useful information and advice as should render it improbable for any designer or operator to go astray. It is all very orderly, plain sailing, and well written. The appendix is really *à propos* of gas-works; and the index is a model of what an index should be. There is so little to say of the work except praise, that it is to be hoped other ideas which have crept into this review may also serve a useful purpose.

H. O. CARR.

* "Modern Gas-Works Practice," by Alwyne Meade. Second Edition. Messrs. Benn Bros., Ltd. Price, 55s. net.

ELECTRICITY SUPPLY MEMORANDA.

MANY small towns are hankering after electric lighting; but when the local authorities sit down calmly and count the cost, and prudence prevails, they become somewhat alarmed at the estimated commitment and the uncertainties surrounding the profitableness of the project. Those who are contemplating starting an independent plant now are doing so with a big handicap, compared with those who were able to inaugurate electricity supply schemes before the war, when capital, plant, materials, appliances, and labour were all cheaper. They should consider this aspect of the matter; for many of the small concerns with the advantage of cheaper plant and installation attaching to them, are struggling hard to live in these times. They are bound, too, to charge high prices in order to keep afloat at all. We are interested in Llandrindod Wells, because there electricity supply was established by an Electric Lighting Company before a gas-works was constructed; and the Gas Company is to-day a dividend-paying concern. The position of the Electricity Supply Company is reflected by the necessity for having to seek authority to charge a maximum of no less than 1s. 2d. per unit for electric light, with a minimum for a winter quarter of 17s. 6d. for fifteen units or less, and a minimum of 11s. 8d. in a summer quarter for ten units or less. The power to do so has been granted; and it is to operate for a period of five years. The report before us states that the District Council feel somewhat unhappy over the increase, and may consider seriously the question of purchasing the undertaking. They had better at the same time "seriously" consider whether they could do better than the Company, without increasing the rates to maintain the electricity concern.

Difficulties of Small Concerns.

Union of Gas and Electricity.

A curious thing is that more of these local authorities, if they really want an electricity supply in their areas, do not thoroughly explore the question of whether they could not do something to facilitate the local gas suppliers (they themselves may be the owners of the gas-works) taking up the supply of electricity as part and parcel of their business. There are many advantages in this, which obviously should tend to a cheaper supply than two separate undertakings. The existing gas suppliers whoever they be have the organization, staff, and fuel—in fact, everything requisite for carrying on the additional business on having installed a generating and distribution system. The combination should make a stronger trading enterprise than two separate concerns fighting for business, in districts incapable of maintaining the two in prosperity, and so ultimately causing the people of the area to pay more for both gas and electricity than there is any occasion to do. The prospects in such areas for gas for all heating purposes are infinitely better than for electricity; and the separate electricity concern is therefore the one that must be placed in the more precarious position. It is ridiculous to suppose that combinations of gas and electricity mean the starving of the latter. If gas-works became electricity suppliers, they are legally bound, within the terms of the governing Acts, to supply all who require current, just the same as they are all who require gas. The Spalding District Council have been considering this matter; but they cannot make-up their minds to incur the expenditure, although the gas-works offer a site and buildings for the purpose. What strongly impresses them is that, if they do

not move, steps may be taken to form a company to carry on the electricity supply in competition with the gas undertaking. And so a small Committee is to consider the matter. It is no use appointing a Committee without competent advice; and what councils in the position of that at Spalding require is to consult a competent firm of engineers who can advise them not only from the electrical side but from the gas side as well. We see, too, that the Llanfairfechan District Council have been reconsidering a decision to carry out an electricity scheme at a cost of £10,000. When the figures and prospects of an independent concern are considered, there is good ground for making a pause.

Gas-Works as Fuel Providers.

The importance of coal stocks was one feature of an address delivered recently by Alderman Walker at the Engineers' Club, Manchester. Electricity undertakings pursue various policies in respect of coal stocks. On every occasion of a dislocation of supplies, some of them are found with barren stores. Idle working capital, coal deterioration, and cost of handling from stock are the excuses; but the pseudo-styled "administrators" of these undertakings rely on a Government Department coming to their aid in the event of a cessation of supplies. The result of this is that diversions are made from those who have been prudent; and this is unfair. Some of those who follow this foolish policy in regard to coal stocks were badly punished during the three months' strike. Alderman Walker (who, by the way, is Chairman of the North-Western Centre of the Institution of Electrical Engineers) protests against the incautious policy. Neither is he favourably disposed towards the use of oil for boiler-firing. From his own experience, he says that 14·5 lbs. of water evaporated per pound of fuel-oil is a fair figure; and as a general proposition, to justify a change from coal to oil, the selling price of the oil must be a little less than double the selling price of coal. The Chief Engineer of an undertaking having the largest oil-burning installation in the country has written on the subject to Alderman Walker; and his experience seems to be that results are very variable, and sometimes inexplicable. On occasion he gets a good result equal to a boiler efficiency of 85 p.ct.; and a little more than 15 lbs. of water evaporated per pound of fuel oil. More frequently, however, inferior results are obtained, for which a reasonable explanation is not always forthcoming. It is pointed out by Alderman Walker that town gas for steam-raising has not made progress; and it seems to him that special provision will have to be made by gas-works for the production and storage of a lower calorific power fuel gas before gas-works can hope to supply the neighbouring electricity station with piped fuel. It would not be any great engineering feat for a gas-works to put up a gas-producer plant, gasify coke or other fuel, and pipe the gas to the generating station. If the anticipations of Prof. Cobb, Mr. Hodsman, and other people materialize, and the steam-oxygen gasification process comes along with its 90 p.ct. efficiency, then with a coal, having a calorific value of 29 million B.Th.U., there would be 26,100,000 B.Th.U. in the gas. Used with the surface combustion system of steam-raising, and an efficiency of 90 p.ct. or so, we should have 23,490,000 B.Th.U. of the original heat value of the coal doing useful duty. But for electricity generation, there are the losses between the steam and the current generated. The gas for electricity generation could be utilized with higher efficiency direct in gas-engines. Alderman Walker is broad-minded over this question of fuel; and he says that gas coke and coke fuel should not be overlooked. Of course not. They have economical virtues—one of which consists in providing an excellent fuel bed which promotes better and cleaner combustion. The economies are to-day attested by considerable experience.

Looking Forward.

Electrical technical opinion is veering round to the view that large power stations should be located as near as possible to the bulk of demand, so as to save transmission costs. This shows how rapidly views change in the electricity supply industry. The colliery was at one time voted to be the proper place for power stations. Then the question of condensing water came in. Now the stations should be near the major part of the demand, so as to bring transmission expenses and losses down to the minimum. This is the view of Mr. R. A. Chattock, Birmingham Corporation Electrical Engineer; and he expressed it in his address to the South Midlands Centre of the Institution of Electrical Engineers. A point in his address in which we are particularly interested is his prediction as to the reduction in future of the cost of generating current. He declared that the demand for electricity will grow at a slightly greater rate than before the war; and he carries his optimistic trend of thought on to saying that, whereas the cost of generation to-day is about 0·96d. per KW.-hour, the cost in 1925 will be 0·44d., or a reduction of 54 p.ct. In 1930 the cost will be about 0·33d. per KW.-hour, or a reduction of 65·7 p.ct. But the consumers know that the whole cost of supplying them is enormously greater than the generating part.

Trade Unions and Force Majeure.

There will have to be an amendment of the law to prevent trade unions exercising autocratically the power of numbers in preventing the carrying on of a public utility supply undertaking if their behests are not observed, though the behests apply to the obligations imposed by the law on those administering the undertakings. Such an amendment we feel is not only essential in the case of electricity supply, but also in respect of other public service undertakings. The point arises from the Hackney case, which has been revived by an appeal by the Borough Council to the King's Bench Division; the appeal being heard by Justices Darling, Sankey, and Branson. The matter can soon be brought to mind. A Mr. Dore required the Council to connect his premises to the electricity supply; he having complied with all the necessary preliminaries. The premises had been wired by a contractor who was neither a member of the Masters' Federation nor of the Electrical Trades Union. The employees of the Council are members of the latter; and they refused to connect the premises with the supply mains. The Council tried to move the Trade Union to permit the work to be done, but they failed. To have carried out the work despite this, might have had far-reaching effects on the electricity supply. This is recognized by the Courts. Mr. Dore brought the Council before a Magistrate. The Council pleaded that there was no default on their part; and even if there was, they were entitled to protection, as it was caused by circumstances amounting to *force majeure*. The Magistrate, while agreeing that "probably" there would have been a calling-out of the trade union men had the work been executed, held that there was default, and that the expression *force majeure* applied only to physical and material restraint, and therefore the Council were guilty of an offence under their Order. Then the appeal by the Council; and the Court held that the Magistrate was right in law. The authorities, their Lordships pointed out, laid it down that even a reasonable apprehension of danger was not in itself *force majeure*. Had the Magistrate said of a certainty—and not "probably"—that there would have been a calling-out of the trade union men, the Court would have found that there was a case of *force majeure*. But Mr. Justice Darling's view, apart from the law, is shown in this sentence: "To very many people it would appear monstrous that this great undertaking should have to wait until a strike actually took place before they could say that *force majeure* came into operation." The electricity industry being the one in which a trade union has originated the policy of obstructing the performance of the legal obligations of a public utility concern, it will have to take seriously into consideration the line of action to prevent a continuance of such tyranny.

Free Wiring.

Mr. Nisbett, whose free-wiring proposal was noticed last week, has been made aware that in it he does not carry with him the whole electricity supply industry. It is not supposed that he thought he would; but he will find his following in the matter a very lean one. The "Electrical Review," commenting on the suggestion, points out that the cost of services is three to four times that of pre-war times, and that in very many cases the profit on the energy used for lighting alone does not even cover the annual charges on the cost of connection. "This is particularly true in the case of the small consumer, whose case Mr. Nisbett obviously has in mind. When he suggests that the supply authority shall bear the cost of the wiring also, he aggravates the difficulty—unless the authority is empowered to charge a remunerative price." The "Electrical Times" says the strongest opponents of free or hire wiring are those station engineers who have had some. Correspondence on the subject in our contemporary has a strong antagonistic tendency.

Financial Assistance.

The electrical papers are delighted over the Local Authorities (Financial Provisions) Act. It is regarded as a measure of great importance to electricity supply undertakings, in respect of the expenditure of capital which will be unproductive for some years. One of the clauses allows of the suspension of sinking-fund payments for a period not exceeding five years while the capital remains unremunerative. Moreover, money borrowed for unemployment schemes within a year of the date of the Act is not to be included as part of the normal borrowings allowed. If the Act will be of considerable use in helping in the development of electricity supply, probably it will not miss rendering equal service to gas supply.

Masonic.—At the last meeting of the Evening Star Lodge, No. 1719, the only matter of importance which took place was the election of the W.M. and the Treasurer. W.Bro. Frank Jervis was elected W.M.; and it is interesting to know that he is at present the W.M. of the Murdoch Lodge. W.Bro. Cyril Davis was elected Treasurer.

A Useful Précis.—There have now appeared very nearly one hundred issues of "A Thousand-and-One Uses for Gas;" and it has been felt by the British Commercial Gas Association that the time has now come to classify and co-ordinate in a tabulated form the large amount of information which has been dealt with in this useful publication. As a result, two numbers (the first of which has already been issued) are to be devoted to a complete *précis* of all those that have already appeared. This compilation will prove of value both to gas undertakings and their consumers. In some cases early issues on any subject have been superseded by later numbers containing fuller and more up-to-date information; and in many instances a single process has been dealt with in several different issues, according to its various aspects. Whether or not this is so, will be discovered on reference to the *précis*. The value of the information to manufacturers need hardly be emphasized; for readers have long recognized it.

TABLE SHOWING HEIGHTS, SPACINGS, &c., OF LAMPS FOR STREET LIGHTING.

Compiled by Mr. W. J. LIBERTY.

IT is of interest, in connection with the paper on "Public Lighting" which was read and discussed at the recent Public Works, Roads, and Transport Congress [*ante*, p. 553], to reproduce this table, which has been forwarded by Mr. W. J. Liberty, the Lighting Inspector to the Corporation of London.

METROPOLITAN AREA.

City of London.	Type of Lamp.	Height.	Height.	Distance Apart.	Width of Street.		Remarks.
					H.P. Lamps.	L.P. Lamps.	
		(Centrally Hung.)	(Posts).	(Average).			
Cannon Street	H.P. gas (Keith) (2000 c.p.)	26'6	16'10	138	50 to 60	..	..
,, ,,	Flame arc (3000 c.p.)	28'0	..	138	,,	..	..
Cheapside	,, ,,	27'6	18'0	90*	50	..	* Shopping thoroughfare. Half lamps turned out at midnight
Holborn Viaduct	"Excello" arcs (4000 c.p.)	..	25'6	175	100	..	..
Queen Victoria Street	H.P. gas (2000 c.p.)	..	13'6	100	70	..	..
New Bridge Street	,, ,,	..	16'10	120	70	..	..
Fleet Street	,, ,,	26'6	..	103	60	..	..
Mansion House area	,, (3000 c.p.)	..	19'6	..	..	..	..
Blackfriars Bridge Approach	,, (2000 c.p.)	..	17'0	..	..	..	..
	Flame arcs	..	18'6	..	..	..	..
Paternoster Row	Electric "M.F." (75 c.p.)	..	12'0	86	..	20	..
Minor Streets	L.P. gas (inverted mantles) (90 and 180 c.p.)	..	11 to 12	80 to 100	..	20 to 30	1921
Main Roads (generally)	"Oliver" flame arc (2000 c.p.)	27'6	..	150	40 to 50	..	..
Westminster	H.P. gas (1800 and 3000 c.p.)	..	20	..	..	..	..
,,	L.P. gas (90 and 180 c.p.)	..	11 and 12	..	..	..	..
,, (Whitehall)	H.P. gas (3000 c.p.)	..	22	..	..	..	..
Aldwych and Kingsway	,, (2000 c.p.)	..	21 6	..	..	..	..
Marylebone	"Union Excello" flame†	..	25'0‡	..	..	..	1911
West Ham	"Brockie Pell" arcs	..	19'0	..	..	..	

† Since changed. ‡ Two lamps on each post.

PROVINCIAL CITIES (GREAT BRITAIN).

	(Heights.)						
Bradford	28	("Oliver" magazine flame)	..	..	..	..	..
Derby	18–22	("Union Excello" flame arc)	..	..	..	..	..
Glasgow	20	("Magazine" flame arc)	..	..	..	..	1911
Leeds	19	("Oliver" flame arc)	..	..	..	..	..
Liverpool	26 6	(Enclosed and gold flame—on	tram pole)	..	..	..	..
Sheffield	23	(Flame arc)	..	..	..	..	..

CONTINENTAL CITIES.

Name of City.	Flame Arc Lamps.	Electric M.F. Lamps.	H.P. Gas Lamps.	L.P. Gas Lamps.	Width of Street.		Remarks.
					For H.P. Lamps.	For L.P. Lamps.	
	(Posts in Feet.)	(Posts in Feet.)	(Posts in Feet.)	(Posts in Feet.)			
Berlin	26 to 39'52	..	14'7 to 18'7	11'5 to 14'7	68 9	..	..
Brussels	..	..	..	11 5 to 14'7	..	..	..
Cologne	26 to 33	11'5	..	11 5	..	..	..
Dresden	26	10'16 and 20	..	10'6	..	..	..
Düsseldorf	29 to 33	..	..	10'2	..	..	..
Munich	33	13	..	11'5	..	..	1909
Paris	13 to 20	..	..	..	..	..	..
Vienna	26 to 39	..	23	11 5	..	..	..
Stüttgart	..	..	Centrally Hung 24 to 28	..	..	..	..

NOTE.—The Austrian, German, Belgian, and French Measurements have been brought to English equivalents for the purpose of comparison.

NATIONAL GAS COUNCIL.

Manchester District Executive Board Meeting.

The Annual Meeting of the Manchester District Executive Board of the National Gas Council was held on Tuesday of last week, in the Council Chamber of the Manchester Town Hall. Alderman WILLIAM KAY, J.P. (Chairman of the Manchester Gas Committee), presided over an assemblage numbering about 75.

The annual report stated that, after making certain adjustments for transfers to other districts, the following table showed the membership of the district as compared with last year:

Year 1920.		Year 1921.		Increase.	
Number of Undertakings.	Annual Make Millions C.Ft.	Number of Undertakings.	Annual Make Millions C.Ft.	Number of Undertakings.	Annual Make Millions C.Ft.
97	35,598	106	36,040	9	442

The membership for Lancashire and Cheshire represented 99 p.ct. of the total make in the two counties. Representations were made to the Central Executive Board respecting the charges for wagon hire; and as a result, a reduction in the proposed intermediate charge was obtained in respect of distances affecting gas undertakings in this district. A questionnaire had been issued from headquarters, and tabulated in the district, to ascertain the extent to which collieries were exercising the power conferred upon them under the directions dated Aug. 25, 1920, by the Board of Trade to charge an additional 2s. 6d. per ton for washed fuel. The information obtained proved to be valuable at the time. As to the standardization of cookers, it was understood that progress is being made, and that the Central Executive Board have approved an interim report of the Special Investigation Committee who have the matter in hand. The report then continued:

Co-Operative Tar Scheme.—An alternative Manchester Co-Operative Tar Scheme, approved by the Commercial Section of the District Institution of Gas Engineers, has been considered and referred to the Central Executive Board for publication. A table showing the relationship between the price paid to the tar producer and the return upon the capital to the distiller was accordingly published in the Council's monthly circular.

Carbon Monoxide Inquiry.—The Management Committee were kept well informed by their representatives on the Central Executive Board of the procedure to be adopted respecting the evidence to be submitted at the Board of Trade inquiry. The District Executive Board are greatly indebted to the Sub-Committee who met at Oldham, and particularly to Mr. R. E. Gibson (Liverpool) for the valuable evidence which he gave at the inquiry. The conclusion arrived at leaves the industry unfettered, which is highly satisfactory.

Gas Incombustibles Inquiry.—The Management Committee followed the proceedings of this inquiry with keen interest. It is very gratifying to know that the Committee appointed by the Board of Trade recommended that no restrictions should be imposed on the industry at least for a period of three years.

Gas Regulation Act, 1920.—Ten gas undertakings in this area have

obtained Orders under the Gas Regulation Act, 1920, and numerous applications are under consideration.

Miners' Strike.—Owing to the unexpected duration of the miners' strike, many undertakings in the area were left with very low stocks of coal. The Management Committee urged the Council to press the Government to purchase imported coal for distribution to gas undertakings, and the Central Executive Board did all that was possible in this direction. Upon a suggestion received from headquarters, a co-operative purchase scheme was formed for those undertakings which were unable to take a complete cargo, and a small Sub-Committee was appointed to carry through the necessary negotiations. Sixty undertakings joined the scheme; and over 26,000 tons of American coal were purchased, excluding Manchester and Salford, who made arrangements direct. It is a pleasure to record that the whole scheme worked satisfactorily, and many undertakings thus avoided closing-down.

The CHAIRMAN, in moving the adoption of the report, spoke of the Board's work during the year, and congratulated the members on working so well together in the co-operative purchase of coal during the miners' strike. The estimated loss to undertakings in this area was £650,000, which was, roughly, 4d. per 1000 c.ft. on the price of gas for a year. As to the future, he thought the country had passed the peak in the matter of coal prices, and that it is now only a question of by how much coal and other materials and labour are to come-down.

The report was approved, and the following appointments were made:

Chairman, Alderman Wm. Kay, J.P. (Manchester); Vice-Chairman, Alderman F. S. Phillips, J.P. (Salford); representative on the Central Executive Board, Mr. R. H. Brown (Birkenhead); Secretary, Mr. J. H. Sillitoe (Manchester).

The following undertakings were elected to nominate a representative on the Management Committee: Birkenhead, Bolton, Burnley, Chester, Liverpool, Oldham, Preston, Radcliffe, Rochdale, Runcorn, Stockport, and Wrexham.

Mr. Fottrell and Mr. Ogilvie addressed the meeting on matters of general interest.

FEDERATION OF GAS EMPLOYERS.

(MANCHESTER DISTRICT.)

Following the meeting of the District Executive Board of the National Gas Council, there was a meeting of the Manchester District Committee of the Federation of Gas Employers, under the presidency of Alderman F. S. Phillips, J.P. (Chairman of the Salford Gas Committee).

The report for the year stated that the number of undertakings now members of the Federation is 80—an increase of 2.

The membership for Lancashire and Cheshire represents 98 p.ct. of the total make in the two counties. A separate District Committee has now been formed for the North Wales area. The zoning and grading of undertakings in the area took many months to negotiate, and was completed last January.

The Employers' representatives on the Executive Committee of the Regional Council are: Alderman F. S. Phillips, Messrs. R. E. Gibson, S. Tagg, and F. A. Pye; and the thanks of the district are due to them for the great amount of time they have given to zoning and grading and the settlement of local disputes. The District Committee acknowledged their great indebtedness to Mr. J. H. Sillitoe for the efficient services he has rendered as Secretary, which have been invaluable to the Committee.

The CHAIRMAN moved the adoption of the annual report, and reviewed the work of the Committee during the year. He drew attention to the amount of work representatives on the Executive Committee of the Regional Council had done for members, and emphasized the good relations which existed between the Federation and the Trade Union representatives.

The report was approved, and the following appointments were made: Chairman, Alderman F. S. Phillips, J.P.; Vice-Chairman, Alderman Kay, J.P.; Secretary, Mr. J. H. Sillitoe (Manchester).

The undertakings elected to nominate a representative to the Management Committee were the same as the District Executive Board reported above, with the exception of Blackburn, in place of Colwyn Bay, which is now in the North Wales area.

Mr. OGILVIE briefly reviewed the work of the Federation from the national point of view.

Monazite Production in India.—From statistics published in the "Bulletin of Indian Industries and Labour," it is shown that in 1918, the last year for which figures are available, the production of monazite sand in India amounted to 2117 tons, valued at £58,819. This was an increase over the production of the previous year of 177 tons, and was a great advance over the last pre-war year, when 1235 tons were produced. In 1911, the production amounted to only 832 tons, valued at £24,044. Regarding the outlook for the future of Indian monazite mining, this is stated to be very promising. In the first place, the reserves are of considerable magnitude, and far greater than those of Brazil or the United States. Mr. J. C. Chacko, the State Geologist of Travancore, estimates approximately the probable total amount of monazite available at about 1,776,000 tons. This calculation assumes that the crude sand contains 10 p.ct. of monazite, and exists to an average depth of 2 ft. In many places, however, its depth is nearer 20 ft. In quality, also, Indian sand easily comes first.

A METHOD OF DISTRICT PRESSURE CONTROL.

By P. S. HOYTE, A.M.I.Mech.E., of Plymouth.

[A Paper read before the Southern Association of Gas Engineers and Managers.]

The kind but insistent pressure which our President has exerted is my excuse for putting before you this short description of a device for district pressure control, particulars of which have already appeared in the Technical Press. If the matter has, therefore, lost the charm of novelty, I hope that the ingenuity of the actual apparatus, the essential parts of which I have brought with me for your inspection, may to some extent compensate you for the tedium of listening to a twice-told tale.

Despite the high state of manufacturing plant efficiency at which we all aim, we are bound to admit there is still a good deal to be accomplished in connection with what I may term the objective of our labours—viz., the maintenance at all times of an even and adequate pressure within our area of supply.

Effective control of these district pressures is by no means an easy matter, particularly to those of us whose efforts are handicapped by unfavourable geographical conditions and the necessity of working old mains at a higher duty than that for which they were originally laid. Extensive relaying programmes cost much money; and although the employment of pressure-raising plants has in many cases furnished a relatively cheap alternative, we are still faced with the difficulty of effectively controlling in our distant districts the conditions so set up. In addition, the operation of the minimum pressure clauses under the new legislation certainly enhances our difficulties in this connection.

Still, "difficulties were made to be surmounted;" and this particular "gadget" is the result of the embarrassments we suffered in vainly endeavouring to maintain a satisfactory pressure at a point some two miles away from the works in a district which at peak-load required upwards of 200,000 c.ft. of gas per hour, and that through a main no larger than 15 in. diameter. It seemed almost as hopeful to sigh for the moon, "Aladdin's Lamp," or an "Alf's Button," as for a device that would synchronize the desire for information as to what was happening two miles away with the actual information itself. But my fervently expressed longing for such an apparent impossibility, coupled with the anxieties of both works and distribution staffs, prompted the fertile brain of my engineering and electrical assistant, Mr. H. C. Widlake*; and before long we were experimenting with a perfect catscradle of wires and tin-cans which promised a path to the hitherto seemingly unattainable.

The apparatus I am about to describe stands out as a radical departure from our existing methods, and places in the hands of the gas engineer the equivalent of an instrument which has from the very beginning of electricity supply business enabled our electrical friends to exercise the most complete control over their distribution system. I allude to the "Pilot Feeder Volt-Meter."

The object of the apparatus is to furnish at the gas-works or some other selected point a continuous indication as to pressure conditions in a district which may be many miles away. The information afforded is not only accurate but varies synchronously with pressure variations in the distant locality. In other words, there is no time-lag between the variation in pressure and the intimation of the variation at the works.

The existing methods of obtaining this information are too well known and long-suffered by you all, to warrant more than a passing comment. Briefly, they include the use of:

(*a*) District pressure men.
(*b*) Telephonic communication between the district and the works.
(*c*) Graphic pressure recorders installed on the district.

(*a*) and (*b*) work in conjunction, affording information which is not only belated, but depends wholly—so far as accuracy and time are concerned—on the human element. Although wholly reliable in regard to time and accuracy, (*c*) possesses the serious disadvantage that the information, generally speaking, comes to hand a day after the existence of the conditions of which it furnishes a record.

So far as accurate and immediate information as to pressure conditions is concerned, these methods are utterly useless; and, generally, the first intimation we have of any untoward happening outside the works is the presence on the telephone of irate consumers.

The instrument consists of two distinct pieces of apparatus:

(*a*) A special form of gas-actuated electrical rheostat, which in practice is installed in a wayleave at the point in a remote district at which information in regard to pressure conditions is required.
(*b*) A sensitive electrical measuring instrument of special construction installed, together with a battery of cells and corrective devices, at the works or other point at which the information is required.

These two portions are connected by means of a loop line, leased at an annual rental from the G.P.O. authorities.

* See illustrated article in the "JOURNAL" for May 18, 1921—"A Long-Distance Pressure Indicator," by H. C. Widlake, A.M.I.E.E.

The principle on which the device works is as follows: Upon the body of the gauge itself is mounted a bank of resistances of high ohmic value (about 600 ohms in the case of the apparatus before you) through which a very small current is always flowing. This current travels from the cells at the works' end to and through the gauge resistances, *vid* one limb of the leased loop line, and back to the other pole of the cells *vid* the other limb. The amount of resistance actually in circuit at any given moment is determined by the gas pressure within the body of the gauge; and it consequently follows that by Ohm's law the magnitude of the current flowing is proportional to the amount of the resistance in circuit.

Bearing in mind that the resistance in circuit is determined by the prevailing gas pressure, you will observe that the current flowing at all times bears a definite relationship to the gas pressure within the body of the gauge. The instrument at the works' end is specially calibrated in units of gas pressure, and the pressure prevailing in the distant district is read direct from its dial without the necessity of any factors of correction or conversion.

The gauge itself is cylindrical, and is so constructed as to form a U tube, the limbs of which are disposed concentrically relative to each other. The pressure of gas in the system to which the gauge is connected acts on the column of water in the outer chamber, causing a corresponding variation in the level of the water in the inner chamber. A circular float fitted within the inner chamber rises and falls with the water, and accommodates the special mercury chamber. A cast-brass spider mounted on pillars on the top of the gauge holds a nest of needles arranged in a spiral circular path on an insulated base. These needles project downwards into the circular mercury-filled trough; the number of needles immersed depending upon the gas pressure within the body of the gauge.

The resistance to which I have alluded, and which is accommodated in an aluminium gallery, is furnished with a number of taps, one of which is soldered to the cap of each respective needle. This spider with its needles and resistance elements is self-contained, and can be removed bodily in thirty seconds for inspection or cleaning.

The apparatus is built and tested to work at a distance of about three miles from the works; and you will notice a bank of tubular resistances placed between the meter and the gauge. These resistances are the equivalent of a leased circuit three miles in length, and have been provided for the purpose of this demonstration in order to reproduce exactly the conditions which would exist were the meter and the gauge three miles apart. [This figure does not represent the maximum range of the instrument, which can be adjusted for working over a range of fifteen miles.] The small set of batteries is not representative of the type supplied with the gauge, and is merely chosen for its small size and lightness, as if the standard batteries were used this demonstration set would be somewhat unwieldy.

The essential parts of the apparatus are included in the set I have here; but, in actual working, sensitive banks of adjusting resistances are installed at the works' end for the purpose of compensating for:

(*a*) Seasonal temperature variations.
(*b*) Variations of battery pressure.
(*c*) Periodically proving the accuracy of the instrument.

The gauge is also supplied with a time-limit switch, which ensures against the possibility of the gauge being inadvertently left in circuit. This refinement I need hardly say is of considerable value, and prolongs the life of the batteries by 600 to 700 p.ct. The cell actually used is a specially made Leclanché, which requires recharging about once every three months.

As a result of our own experiments with the apparatus, I may say that during the seventeen months we have had it in use, it has proved entirely and continuously reliable, and has never caused us a moment's anxiety, even in the severest winter weather.

The following are some few of the advantages which we have enjoyed since its adoption:

(*a*) The gas pressure prevailing in our most important district can be seen at all times, with no greater effort than is required to read the dial of a timepiece.
(*b*) The apparatus paid for itself in the first few months of working, in the saving in wages of district pressure testers.
(*c*) Any pressure variations are recorded synchronously with their occurrence, and the works' staff receive instant indication of the smallest variation.
(*d*) Disputes and disagreements between the works and distribution staffs on the subject of district pressures no longer exist.
(*e*) We find a considerable saving is effected in boosting plant fuel and attendance charges, as the works' staff being kept automatically acquainted with district pressure conditions, the plant is only run-up when actually required; it is not put on early and shut-down late in order to be "on the safe side."
(*f*) In addition to this saving, the boosting plant is run under a much smaller load, as, the district pressure being known, the sets are run at whatever speed is necessary to maintain the desired pressure, and are not overrun simply in order to be again "on the safe side." Such practice, in addition to waste of fuel, throws useless work on both the plant and the district governors.
(*g*) We find that the use of the apparatus has induced on the part of the men responsible for the proper maintenance of district pressures a sense of confidence and security which is very difficult to describe effectively. This psychological factor can only be fully appreciated by anyone who enters into conversation with men who, after years of working to the old methods, have actually experienced the manifold conveniences which the new instrument, with its scientific certainty and absolute reliability, confers upon its users.

The gauge was, of course, primarily designed for use in connection with the maintenance of district pressures; but I cannot help feeling that there is a wide sphere of usefulness for it within the boundaries of a gas-works, for the purpose of centralizing the more important of the manufacturing plant pressure gauges. The advantage of having this are too obvious to need much emphasis, as at present the position of any chokage or irregularity can only be determined after a visit to a number of more or less scattered points where pressure-gauges are installed. In this manner much valuable time may be lost, and no account is taken of the fact that conditions may have changed while the plant attendant is making his round of the gauges. Used in this connection, the gauge would differ very materially from the one you see before you, although the working principle would remain the same.

The attitude of the Post Office telephone authorities towards the device is distinctly favourable, and they are prepared (engineering conditions permitting) to provide accommodation for the instruments in any town at a fixed annual rental. The conditions upon which these services are given are not onerous, and place no difficulties in the path of intending purchasers.

So far as annual rental charges are concerned, I may say that our own installation at Plymouth, where the distance between the works and the part of the Mutley district in which the gauge is fixed is about two miles by road, we pay an annual rental of about £13.

It has been suggested to me that the fact of the instrument's involving an intending user in a yearly rental charge for circuit accommodation is a drawback; and I am glad of the opportunity which the reading of the paper affords me to deal with this criticism. The incurrence of an annual rental charge in connection with this apparatus is unavoidable; but the only fair method of regarding this item is to consider it in connection with the benefits which the use of the gauge confers. Thus in our own case, for the comparatively trifling sum of 5s. per week, we obtain the most complete control over and knowledge of pressure conditions in a district which has for years been a source of trouble and anxiety to us; and I may say we should regard the information as cheap at many times the figure I have mentioned.

In the case of gas undertakings employing pressure testers in their various districts, it will readily be seen that five or six districts could be placed in constant touch with the works at a total annual rental for accommodation lines of less than the yearly wage of a single pressure tester. Pursuing this comparison still further, the pressure testers' information would be very intermittent and available only during the working day, while the information afforded by the alternative method of long-distance pressure registration would be "on tap" as it were continuously throughout every moment of the twenty-four hours.

Various special arrangements are possible at the works end of the line, whereby pressure indications from distant districts can be shown at any reasonable number of points on the works, or can be connected through to any desired point in exactly the same manner as the telephone is connected through to (say) an engineer's or district superintendent's house after office hours.

THOMPSON'S WATER-TUBE BOILERS.

Information has come to hand that Messrs. John Thompson, of Wolverhampton, have secured the contract for water-tube boilers for the Morwell Power-Station scheme of the State Electricity Commissioners of Victoria, Australia. It is understood that this was in face of keen American competition; and the firm are to be congratulated on that score.

The contract is for twelve Thompson patent straight vertical water-tube boilers, working pressure 260 lbs. per sq. in., each to evaporate 70,000 lbs. of steam per hour, and fitted with superheaters to raise the steam to a final temperature of 650° Fahr. Each boiler will be fitted with three underfeed forced-draught travelling grate stokers to burn Morwell brown coal. This coal, we believe, is found practically on the earth's surface; and the power-station is being erected adjacent to the fuel bed. The boilers will be complete with chimneys, flues, and automatic soot and ash extracting and disposal plant.

News of this kind is very heartening in these lean days; and Messrs. Thompson, whose present construction work includes six boilers for the Metropolitan Railway Neasden project, must feel very gratified.

The American Gas Association, at their recent annual meeting, held in Chicago, unanimously elected Mr. Thomas Hardie, M.Inst.C.E., an honorary member of the Association, for the period of his office as President of the Institution of Gas Engineers.

GASEOUS COMBUSTION AT HIGH PRESSURES.

THE EXPLOSION OF HYDROGEN-AIR AND CARBON MONOXIDE-AIR MIXTURES.

By WILLIAM ARTHUR BONE, D.Sc., Ph.D., F.R.S., and the late WILLIAM ARTHUR HAWARD, M.Sc., Salters' Research Fellow.*

[Reprinted, by permission, from the "Proceedings" of the Royal Society.]

INTRODUCTION.

In a previous paper upon the subject,† the question was propounded whether or not there is any direct relation between the actual rate at which the potential energy of an explosive mixture is transferred on explosion as sensible heat to its products and the magnitude of the chemical affinity between its combining constituents. As the result of an experimental inquiry into the matter, it was proved:

(*a*) That, whereas the affinity for oxygen of methane is at least twenty to thirty times greater than that of hydrogen, the time required for the attainment of maximum pressure in the case of the primary methane-air mixture ($CH_4+O_2+4N_2$) is at least some five to eight times as long as that required in the case of the primary hydrogen-air mixture ($2H_2 + O_2 + 4N_2$).

(*b*) That, whereas in mixtures corresponding to $CH_4 + O_2 + xH_2$ (in which x was varied between 2 and 8), the "mass influence" of successive increases in x upon the actual oxygen distribution between the two combustible gases is proportional to x^2, yet in mixtures corresponding to $CH_4 + O_2 + xCO$ it is nearly proportional to x; or, in other words, while the "mass influence" of hydrogen is proportional to the square, that of carbon monoxide is in accordance with the first power, of its concentration.

(*c*) That in hydrogen-air and carbon monoxide-air mixtures corresponding to $2H_2 + O_2 + 4N_2$ and $2CO + O_2 + 4N_2$, respectively, in which the combustible gas and oxygen are present in their combining proportions, and which on explosion develop practically the same total energy (equivalent to 68·4 K.C.U. per gram-molecule in the case of hydrogen, and 68·0 in the case of carbon monoxide), the time taken for the attainment of the maximum pressure on explosion is at least ten times longer in the case of carbon monoxide than in that of hydrogen.

It thus appeared that the rate at which the potential energy of an explosive mixture is transferred into thermal energy, as measured by the rise in pressure when the explosion is carried out in a closed vessel, is not primarily determined by the chemical affinity between the combustible gas and oxygen, as ordinarily understood, but by some other factor or circumstance, then unknown, and which, therefore, required closer investigation. The present paper embodies the results of further experiments upon the matter.

EXPERIMENTAL.

Apparatus and Experimental Method.—The apparatus and methods employed in these further experiments have been substantially the same as those already described in the previous paper. Seeing, however, that it was now desired always to obtain optical records of the complete pressure curves on exploding the various experimental mixtures, we employed throughout the spherical bomb B, to which was attached the Petavel recording manometer with its optical accessories. The bomb had a spherical cavity 3 in. in diameter (capacity approximately 275 c.c.), which, when fitted with its coned admission valve, ignition plug, and the Petavel manometer, was easily capable of holding-up a pressure of 600 atmospheres. The reader is referred to the former paper for details concerning (*a*) the mode of admitting and mixing the various constituents of the gaseous mixture at the outset of each experiment, (*b*) the ignition device, and (*c*) the optical recording of the pressure during the explosion which followed. An electrically controlled tuning-fork, giving 100 vibrations per second, was employed as a time indicator, the fork being so placed that each vibration momentarily interrupted the light falling on to the photographic film of the pressure-recording apparatus, thus producing a dotted instead of a continuous pressure curve. We were thus able to measure the time taken in each experiment for the attainment of maximum pressure to within 0·005 sec., but not much closer, which, however, was sufficiently accurate for our purpose.* Certain minor improvements made in the optical arrangements since the previous research enabled us to obtain even better pressure records, which could therefore be read and measured with somewhat greater accuracy than before. The ratio of the *maximum* to the *initial* pressure could usually be determined to within about 1 p.ct. of the true value, or (say) to the first decimal place.

The substantial purity of the gases employed for making the various experimental mixtures was in each case always established by chemical analysis. The nitrogen and hydrogen used had been bought from trustworthy sources, in cylinders under 100 atmospheres pressure. The carbon monoxide and oxygen were prepared in the laboratory (by methods already described in the previous paper) and then compressed on the spot into cylinders up to 100 atmospheres before use.

Altogether 52 experimental mixtures, the exact compositions of which were subsequently determined by analysis, were exploded in the bomb, each at an initial pressure of 50 atmospheres. The results of the first 20 were, however, discarded as being somewhat less reliable than the rest, because of a suspicion that in some of them there might have been a slight lag in the rising pressure curve due to a possible sticking of the moving parts of the Petavel manometer, which was thereupon thoroughly cleaned and overhauled. With one or two exceptions, the records obtained in the remaining 32 experiments, when the manometer was working at its maximum sensitiveness, were all remarkably clear and concordant. The results of some 18 of them were finally selected for the purpose of this paper.

During the course of the research, the tightness of the bomb, and the condition of the surface of its explosion chamber, were frequently tested by exploding in it mixtures of oxygen with excess of hydrogen. This precaution was always necessary after any experiment in which (as was sometimes the case) an experimental mixture containing an excess of oxygen had been exploded, with consequent possible slight oxidation of the walls of the explosion chamber. Such experiments were, therefore, always followed by a series of oxygen with excess hydrogen explosions, until the resulting contraction was observed to be exactly equal to three times the partial pressure of the oxygen originally taken. More than 40 optical calibrations were made of the Petavel manometer during the research, from which the various optical explosion pressure records were subsequently gauged.

It was assumed that any slight deviation of the four diatomic gases, hydrogen, carbon monoxide, nitrogen, and oxygen, from Boyle's law, within the experimental condition, might be considered as negligible for practical purposes; and actual trials in the bomb of the compressibilities of hydrogen and nitrogen, respectively, confirmed this view. In cases where mixtures containing carbon monoxide were exploded, the observed final pressure of the cold products (P_f) were always "corrected" for the ascertained deviation of their carbon dioxide-content from the law.

In the tabulated experimental results:

P_i = the initial pressure in atmospheres at which each mixture was fired.

P_m = the maximum pressure in atmospheres attained in the explosion.

P_f = the final pressure in atmospheres of the cooled products of combustion.

P_k = the actual pressure in atmospheres of the real "knall-gas."

t_m = time in seconds taken for the attainment of maximum pressure after ignition.

Σ = the thermal equivalent in K.C.U. of the total energy liberated during the explosion.

FIRST SERIES.—*Experiments with Mixtures* $2H_2 + O_2 + 4X_2$ (*where* $X_2 = N_2$, H_2, *or* O_2).

In each of these experiments, the object of which was to find to what extent (if at all) the rate of attainment of maximum pressure in a hydrogen-air mixture ($2H_2 + O_2 + 4N_2$) would be affected by the substitution for the diluent nitrogen of an equivalent molecular proportion of hydrogen or oxygen, the original mixture was fired at an initial pressure of 50 atmospheres. It was very difficult, indeed hardly possible, always to make the mixtures of *exactly* the intended composition; but by selecting for comparison those in which the difference between the initial and final pressures of

* This paper had been drafted for communication to the Royal Society only a few days before the occurrence of the accident in my laboratory (Dec. 6, 1920) which so tragically ended poor Haward's life [See "JOURNAL," Vol. CLII., p. 630]. He was suddenly struck down by death while actually engaged upon some final experiments designed to test and develop some of the theoretical issues set forth in the concluding paragraphs. This further part of the work will have to be completed by other hands than his, now that the apparatus has been overhauled and its damaged parts made good. Meanwhile, Haward's experimental results are being published in practically the same form as he last reviewed them with me, not only because of their exceptional interest, but also as a tribute to his great experimental skill and passionate devotion to scientific research. He laid down his life in the cause of science at the age of 26 years.—W. A. B.

† See "JOURNAL," Vol. CXXXIII., p. 140.

* In amplification of this statement, it may be explained that the recording apparatus enabled us to measure quite definitely 0·005 sec., which in most of the experiments was less (and in some considerably so) than the time actually taken to attain the maximum pressure. And in such cases the record of the pressure curve obtained was invariably a line free from any sign of "vibration" either in passing through or after attaining the maximum point. On the other hand, in one or two experiments, in which the maximum pressure was attained in less than 0·005 sec., the record showed some sign of such vibration just after the maximum had been reached.

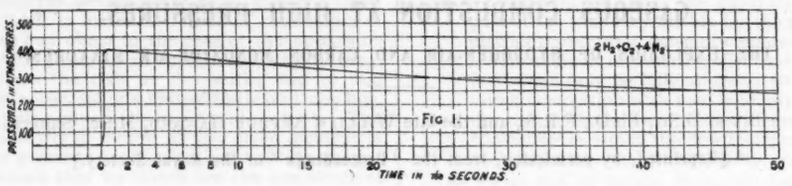


FIG. 1.

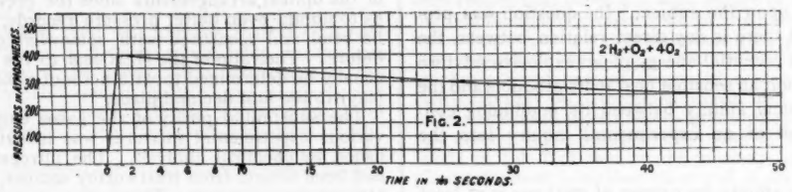


FIG. 2.

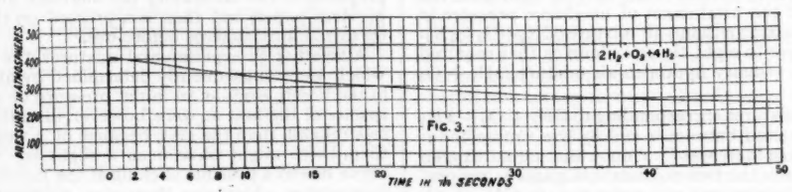


FIG. 3.

the cold mixture and products, respectively, was as nearly as possible equal to 21·4 atmospheres, any experimental error due to such cause was minimized. The results of six typical experiments are tabulated.

TABLE I.—*Results of Experiments (First Series) with* $2H_2 + O_2 + 4X_2$ *Mixtures.*

Experiment	I.	II.	III.	IV.	V.	VI.
Mixture	$2H_2+O_2+4N_2$.			$2H_2+O_2+4O_2$.	$2H_2+O_2+4H_2$.	
Initial temp., C.	18·5°	17·5°	14·7°	22·5°	11·0°	11·0°
Pressures in atmos. P_i	50·0	50·0	50·0	50·0	50·0	50·0
Pressures in atmos. P_k	21·7	21·2	21·7	21·5	21·8	21·7
Pressures in atmos. P_f	28 8	28·5	28·3	28·8	28·2	27·5
Pressures in atmos. P_m	405	391	402	400	408	408
Ratio P/P^i	8·1	7·8	8·04	8·0	8·16	8·16
t_m secs.	0·005			about 0·010	about 0·0025	
Σ K.C.U.	10·45	10·18	10·50	10·33	10·48	10·40

We succeeded in obtaining three exceptionally good records of the pressure curves in the hydrogen air ($2H_2 + O_2 + 4N_2$) mixtures, one of which (Experiment I.) is reproduced in fig. 1. They each showed an almost instantaneous rise (in about 0·005 sec.) to the maximum pressure of about 400 atmospheres, the attainment of which was immediately succeeded by the commencement of the cooling period. The cooling curves, however, all gave some indication of there having been a slight evolution of heat during a short period (about 0·10 sec.) after the actual attainment of the maximum pressure, thereafter becoming straight lines.*

It is of interest to compare our time-pressure curve with the time-temperature curve deduced by Prof. W. T. David from his recent experiments on "Radiation in Explosions of Hydrogen and Air" for the explosion of a mixture of nearly the same composition (a 25·4 p.ct. hydrogen mixture) as ours in a closed vessel with blackened walls at atmospheric pressure. His maximum temperature (2400° C. abs.) was reached in 0·017 sec. after ignition; and his cooling curves gave no indication of any heat evolution occurring in the system after the maximum temperature had been passed. He also found that the mixture in question lost as much as 16·1 p.ct. of its total potential energy (heat of combustion) by radiation, nearly the whole of which was emitted during the cooling period at a rate approximately proportional to the fourth power of the absolute temperature. It may also be noted that, whereas until the temperature had fallen to 1200° C. abs. this radiation consisted chiefly of the 2·8 band of "steam" (as found in a hydrogen flame), at the highest temperature (2400° to 2200° C. abs.) some radiation of shorter wave was emitted; also that below 1200° C. abs. (at which the 2·8μ line had almost ceased) some of greater wave-length could be detected. The fact that the emission of radiation of shorter wave-lengths than 2·8μ has been detected at the highest temperature during hydrogen-air explosions, seems to us to be of some significance in connection with the theory of combustion, suggesting, as it does the initial transitory formation of an intensely vibratory complex when hydrogen and oxygen combine in flames—a consideration that will be referred to again in the concluding part of this paper.*

From Table I., it will be seen that the substitution of hydrogen or oxygen for nitrogen as the diluent gas had no very marked influence upon the course of the explosion. If anything, the substitution of hydrogen quickened, and that of oxygen somewhat retarded, the attainment of the maximum pressure. Also, the substitution of hydrogen tended to quicken slightly the cooling—as, indeed, might be expected from its greater heat conductivity and mobility than nitrogen. Two typical curves, one for the mixture $2H_2 + O_2 + 4O_2$ (Experiment IV.), and the other for the mixture $2H_2 + O_2 + 4H_2$ (Experiment V.), are reproduced in figs. 2 and 3 respectively; and in Table II., the three curves are analyzed.

TABLE II.—*Analysis of Curves shown in Figs. 1, 2, and 3.*

t. (Seconds after Ignition)	Fig. 1. Experiment I. $2H_2 + O_2 + 4N_2$. P. Atmos.	Fig. 2. Experiment IV. $2H_2 + O_2 + 4O_2$. P. Atmos.	Fig. 3. Experiment V. $2H_2 + O_2 + 4H_2$. P. Atmos.
0·000	50	50	50
0·025 to 0·010*	405	400	408
0·050	385	380	371
0·100	358	355	343
0·150	337	337	320
0·200	317	320	300
0·300	282	288	267
0·400	260	263	242
0·500	237	242	222
0·600	218	221	204
0·700	198	205	189
0·800	185	190	—
0·900	174	179	—
1·000	164	168	—

* This represents t_m, the time taken for the attainment of P_m, which varied between 0·0025 and 0·010 sec. in the different experiments (*vide* Table I.).

SECOND SERIES.—*Experiments with Carbon Monoxide-Air Mixtures.*

$2CO + O_2 + 4N_2$.

For comparison with the behaviour of the foregoing hydrogen-air mixtures (Experiments I. to III. inclusive), the following three Experiments VII. to IX. inclusive) with CO-air mixtures ($2CO + O_2 + 4N_2$), liberating the same total amount of energy upon combustion, were made. Unfortunately, the original mixture in Experiment VII. was afterwards found to have been weaker (CO = 26·35 instead of 28·6 p.ct.), and that in Experiment IX. slightly stronger (CO = 30·1 instead of 28·6 p.ct.), than had been intended. In Experiment VIII., however, the mixture was of exactly the right composition; and therefore its results were finally selected for detailed comparison with those of the correspondingly best experiment with the hydrogen-air mixture (Experiment I., *q.v.*). In all cases most excellent records were obtained of the pressure curves, one of which (from Experiment

* In the previous paper, the time observed for the attainment of maximum pressure for similar mixtures of $2H_2 + O_2 + 4N_2$, when fired in the bomb at initial pressures of 50 atmospheres, was 0·010 sec., and the succeeding cooling-curve was practically a straight line throughout. This slight difference between the new and the old results is to be ascribed to the somewhat greater sensitiveness of the pressure-recording part of the apparatus in the present research than formerly.

* Prof. David himself rather suggested that it might be due to the presence of nitrogen in the exploded gases, because nitrogen gives a strong emission band at 1μ in a vacuum tube. But it may be doubted whether nitrogen would become emissive in an explosion; and the above interpretation seems to be the better one.

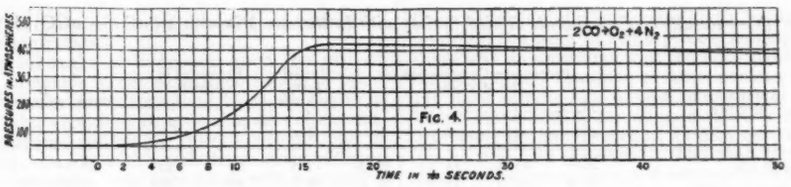


FIG. 4.

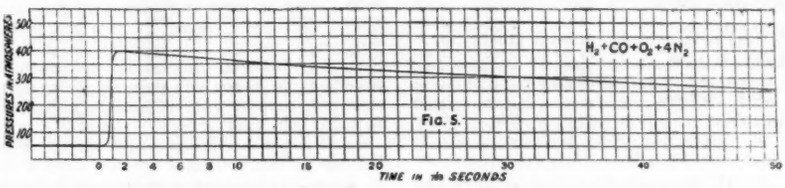


FIG. 5.

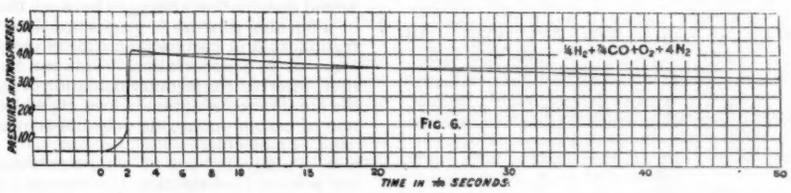


FIG. 6.

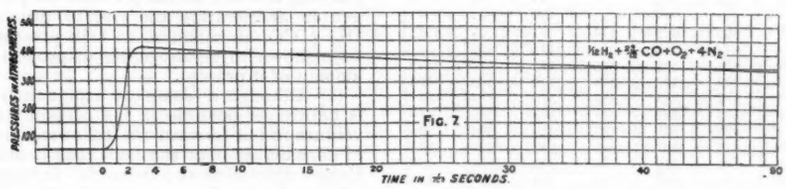


FIG. 7.

VIII.) is reproduced in fig. 4 and analyzed in detail. The results of the whole series are epitomized in Table III.

Comparing now figs. 1 and 4, it will at once be seen how strikingly dissimilar was the whole course of the combustion and subquent cooling, though the total energy developed was as nearly as possible the same, in the two cases. In the case of the CO-air mixture (fig. 4), not only was the ratio P_m/P_i distinctly higher, but the time taken for the attainment of maximum pressure (t_m) was about 36 times longer than in the corresponding experiment (fig. 1) with the H_2-air mixture. It may here be stated that there were indications that the time in question was not quite so constant in the CO-air series as it had been in the H_2-air series, being apparently influenced to some extent by the hygroscopic state of the mixture—as, indeed, might be expected from H. B. Dixon's well-known work on the combustion of carbon monoxide. It is intended, in future experiments, to investigate this particular point more fully, as it appears to be of practical interest in connection with internal combustion engine problems.

TABLE III.—*Results of Experiments (Second Series) with* $2CO + O_2 + 4N_2$ *Mixtures.*

Experiment	VII.	VIII.	IX.
Per cent. CO in the mixture	26·35	28·6	30·1
Initial temp. C.	16·5°	18·2°	18·5°
Pressures in atmos. P_i	50·00	50·00	50·00
Pressures in atmos. P_k	19·75	21·45	22·50
Pressures in atmos. P_f (corrected)	41·80	41·50	41 66
Pressures in atmos. P_m	378	421	410
Ratio P_m/P_i	7·56	8·42	8·2
t_m secs.	0·24	0·18	0·19
Σ K.C.U.	9·43	10·23	10·78

Another notable difference between the two curves in question is that, whereas in the case of the hydrogen-air mixture the cooling commenced almost immediately after the attainment of the maximum pressure, in the case of the CO-air mixture it was delayed for quite an appreciable time interval thereafter, showing that heat energy was still being liberated long after the maximum temperature had been reached. Also, the subsequent rate of cooling after t_m was very much slower in the CO-air than in the H_2-air series. Indeed, nothing could be more strikingly different than the modes of combustion of carbon monoxide and hydrogen as revealed by these two curves. An analysis of the CO-air curve (fig. 4) is given below:

Analysis of CO-*Air Pressure Curve.* (*Fig.* 4.)

Time (secs.) after ignition	0·00	0·05	0·10	0·15	0·18	0·20	0·25
Pressure (atmos.)	50	76	173	398	421	421	416

Time (secs.) after ignition	0·30	0·40	0·50	0·60	0·70	0·80	0·90	1·00
Pressure (atmos.)	412	395	383	373	362	352	342	332

Indeed, a detailed comparison between the results of the two sets of Experiments I. to IV. (with H_2-air mixtures) and VII. to IX. (with CO-air mixtures) respectively, has shown that, in the latter, not only was there always an interval of about 0·05 sec., during which the maximum pressure was fully maintained, but also, subsequently, the pressure fell at only half the rate it had done in the former.

THIRD SERIES.—*Experiments with Isothermic Mixtures* $2(mH_2 + nCO) + O_2 + 4N_2$.

It now seemed important to determine whether or not the marked disparity observed in the preceding series of experiments between the rates of attainment of maximum pressure in the H_2-air and CO-air mixtures, respectively, can be ascribed to some difference in the molecular properties of the two combustible gases concerned. If so, then their separate influences upon the rate of attainment of maximum pressure should be *additive* when isothermic mixtures $2(mH_2 + nCO) + O_2 + 4N_2$ (where m and n are variable, but $m + n = 1$) are exploded at the same initial pressure. On the other hand, if their effects are not additive, then the cause of the disparity in question must be sought for elsewhere.

All that was needed to settle experimentally this fundamental issue was to explode a series of such isothermic mixtures at the same initial pressure (50 atmospheres), and, from the pressure records, to compare the time actually taken in each case for the attainment of maximum pressure with that calculated on the supposition that the separate influences of hydrogen and of carbon monoxide are additive. This was accordingly done in the series of experiments in Table IV., with results which were certainly conclusive against any such supposition.

The very decisive character of these results will be made clear by a comparison of the pressure curves (figs. 5. 6, and 7) obtained in Experiments X., XIV., and XVIII., respectively, with those already reproduced (figs. 1 and 4, respectively) in connection with the H_2-air and CO-air series, respectively.

It will be observed that in each of the above curves the sharp and almost vertical rise up to the point of maximum pressure, and the abrupt turning downwards thereafter, closely resemble the hydrogen-air curve (fig. 1, *q.v.*). Indeed, there was hardly any feature in the rising-pressure curves to suggest the influence of carbon monoxide, except perhaps in the case of mixtures containing more than seven volumes of CO to one of H_2, where it could just be traced for something like 0·005 second after ignition, during which the initial part of the rising curve was a little rounded. All this means that, in some way or other, which has yet to be explained, the presence of even 1 p.ct. (and probably less) of hydrogen in a CO-air mixture, at the high initial pressures employed by us, has an altogether disproportionately large influence in accelerating the rise of pressure on explosion. Indeed, such a small proportion of hydrogen seems capable of imposing its own character upon the whole course of the subsequent combustion at such pressures.

TABLE IV.—*Results of Experiments (Third Series) with Isothermic Mixtures* $2(mH_2 + nCO) + O_2 + 4N_2$.

Expt.	Approximate Mixture.	Percentage Composition of the Mixture.				Initial Temperature, C. Deg.	Pressures in Atmos.		Ratio P_m/P_i.	t_m (secs.) Observed.	Σ K.C.U.
		CO.	H_2.	O_2.	N_2.		P_i.	P_m.			
II.	$2H_2+O_2+4N_2$	*Nil*	28·20	14·50	57 30	17 5	50	391	7·82	0·005	10·18
X.	$H_2+CO+O_2+4N_2$ . .	14·5	13·0	15·1	57·4	20·5	50	399	7·98	0·015	9·87
XI.		13·65	13·85	14·90	57·60	20·4	50	390	7·80		
XII.	$\frac{1}{3}H_2+\frac{2}{3}CO+O_2+4N_2$ . .	19·90	6·70	14·55	58·85	21 5	50	410	8 2	0·015	9·54
XIII.	$\frac{1}{4}H_2+\frac{3}{4}CO+O_2+4N_2$.	21·95	3·55	14·20	60·30	20	50	409	8·2	0·025	9·12
XIV.		22·90	3·60	14·30	59·20	20	50	418	8·36		9·49
XV.	$\frac{1}{8}H_2+\frac{7}{8}CO+O_2+4N_2$.	24·60	2·20	14·00	59·20	13	50	427	8·54	0·025 to 0·030	9·60
XVI.		24·80	2·00	13·80	59·40	14	50	425	8·50		9 56
XVII.	$\frac{1}{12}H_2+\frac{11}{12}CO+O_2+4N_2$	25·60	1·45	14·05	58·90	14·5	50	417	8·34	0·030	9·69
XVIII.		25·50	1·10	14·30	59 10	13	50	425	8·50		9·53
VIII.	$2CO+O_2+4N_2$	28·6	*Nil*	16 0	55 4	18·2	50	421	8·40	0·180	10 23

TABLE V.—*Analyses of the Pressure Curves in Third Series.*

Experiment . . .	II.	X.	XII.	XIV.	XVI.	XVIII.	VIII.
Ratio H_2 : CO in the mixture exploded	2 : 0	1 : 1	1 : 3	1 : 7	1 : 11	1 : 23	0 : 2
t. (Secs. after Ignition)	P. Atmos.	P. Atmos.	P. Atmos.	P. Atmos.	P. Atmos.	P. Atmos.	P. Atmos.
0·000	50	50	50	50	50	50	50
0·005	391*	..	175	..	..	..	..
0·010	..	350	350	65	63	..	..
0·015	385	399*	410*	..	..	..	..
0·020	..	..	..	108	..	..	..
0·025	380	395	405	418*	..	..	55
0·030	..	..	..	..	425*	425*	..
0·050	368	382	397	399	415	418	75
0·100	340	362	380	381	398	403	175
0 200	298	327	354	357	379	382	421*
0·300	264	302	333	341	363	365	412
0·400	242	278	318	327	349	352	395
0·600	198	243	291	307	327	332	373
0·800	174	219	270	289	309	312	352
1·000	152	194	248	273	292	298	332

* The asterisk denotes the attainment of the maximum pressure (P_m) in each case.

Analyses of the cooling curves obtained in this series (*vide* Table V.) are of some interest, in that they show very distinctly how the progressive replacement of steam by carbon dioxide in the products retarded the pressure-fall after the maximum point had been passed.

DISCUSSION OF RESULTS.

(1) To chemists who have specially studied gaseous combustion, there has always been something peculiarly enigmatical about the very different behaviours, in many respects, of the two simplest combustible gases, carbon monoxide and hydrogen. And even those who have not gone very deeply into the matter must have been struck with certain obvious differences between their flames. This enigma may, perhaps, best be expressed by saying that, while the volumetric heats of combustion of the two gases, and also the volumetric proportion in which each of them combines with oxygen, are the same—

e.g., we usually write $\begin{cases} 2H_2 + O_2 = 2H_2O. \ . \ 68{\cdot}4 \\ 2CO + O_2 = 2CO_2. \ . \ 68{\cdot}0 \end{cases}$ K.C.U. per gramme molecule—

yet in almost all other respects their modes of combustion present a strikingly wide contrast.

(2) Thus, for example, (*a*) hydrogen-air mixtures have lower ignition temperatures, and, under similar physical conditions, propagate flame much faster, than the corresponding CO-air mixtures; (*b*) the flame of hydrogen burning in air is smaller and "sharper" than a similar flame of carbon monoxide (*i.e.*, burning at the same orifice and under the same pressure)—indeed, the CO flame is always described as "lambent," and its appearance suggests a *slower burning* gas than hydrogen; and (*c*) when corresponding H_2 air and CO-air mixtures are respectively exploded in a closed vessel, the pressure rises to a maximum *rapidly* in the case of hydrogen, but *slowly* in the case of carbon monoxide.

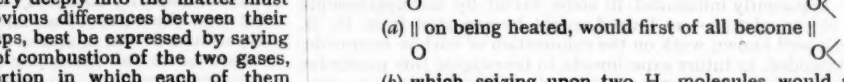
(3) These three contrasts all suggest that carbon monoxide has greater difficulty than hydrogen in getting oxidized in flames. In fact, ever since H. B. Dixon's classical researches, it has been known that the presence of even a minute quantity of steam greatly assists, if it is not absolutely essential to, the oxidation of carbon monoxide in flames. And it can easily be shown that a flame of the *dry* gas is extinguished on being introduced into a jar of air that has been dried over strong sulphuric acid. The precise mode in which steam accelerates or determines the combustion of carbon monoxide has, up to the present, never been completely explained. But chemists are generally agreed that the phenomenon in question is due to some peculiar inertness of CO for O_2 molecules in flames, which the presence of steam, somehow or other, overcomes. We are, therefore, justified in concluding that, in ordinary flames, carbon monoxide cannot interact with undissociated O_2 molecules.

(4) Another very significant difference between the respective behaviours of hydrogen and carbon monoxide in flames, which has already been referred to in the introductory portion of our paper, is the fact (first published by one of us in 1916) that, while what may be termed the "mass influence" of hydrogen upon the actual distribution of oxygen between the combustible constituents of a burning mixture is proportional to the *square* of its concentration, that of carbon monoxide is nearly proportional to the *first power* of its concentration. This can hardly mean otherwise than that, whereas the primary oxidation of hydrogen in flames involves the simultaneous action of two H_2 molecules, the primary oxidation of carbon monoxide does not require the action of more than one CO molecule.

(5) Finally, in view of what has been brought to light during our present investigation, there must now be added to the other puzzling features of the problem the peculiar influence of hydrogen in accelerating the rise of pressure in the explosion of $(H_2 + CO)$-air mixtures at high pressures, an effect which has been shown to be altogether disproportionate to the volumetric amount of it present.

(6) Although a complete explanation of the foregoing facts is hardly yet possible, in the present state of our knowledge, we venture to put forward the following view tentatively, as worthy of consideration, in the hope that it may provoke and stimulate further discussion and research. It involves the conception that, whereas in certain cases of combustion (such as that of hydrogen), undissociated O_2 molecules can, and ordinarily do, interact directly with those of the combustible gas, yet in other cases (such as that of carbon monoxide), the dissociation of the O_2 molecules is a necessary precedent to the actual oxidation; or, in other words, that oxygen in flames may function in two distinct ways—namely (*a*), as undissociated O_2, and (*b*) as dissociated and atomic O.

(7) According, then, to this conception, it may be supposed that an undissociated O_2 molecule, on being raised to a certain moderately high temperature in the flame, has its "residual affinities" sufficiently stimulated to enable it to seize upon, and grip hold of, two undissociated hydrogen molecules, forming initially an unstable vibratory complex H_4O_2, thus:



(*a*) $\begin{matrix} O \\ \| \\ O \end{matrix}$ on being heated, would first of all become $\begin{matrix} O\diagdown \\ \| \\ O\diagdown \end{matrix}$.

(*b*) which, seizing upon two H_2 molecules, would momentarily form the unstable complex,

$$\begin{matrix} O\diagdown H \\ \| \\ O\diagdown H \end{matrix} \quad \begin{matrix} H \\ H \end{matrix}$$

(8) Such a complex, being in an intensely vibratory condition, would instantly break-down, partly (i) into two molecules of steam, also in a vibratory condition, and therefore chemically "activated," and partly also (ii) into two H_2-molecules and two O atoms, thus:

say, 100 $\begin{pmatrix} O\diagdown H \\ \| \\ O\diagdown H \end{pmatrix}$ would give rise to (simultaneously) $\begin{cases} \text{(i) } n \times 2 : O\diagdown H \\ \qquad\qquad H \\ \qquad \text{and} \\ \text{(ii) } (100-n)\,(2O : +2H_2). \end{cases}$

The ratio $(n/100n)$ would obviously depend upon both temperature and environment: The higher the temperature, and the less hydrogen in the environment, the less the magnitude of n. In some such way, however, it may be supposed that hydrogen, in a combustible mixture containing also CO, could function as a resolver of O_2 molecules simultaneously into (i) "activated" steam and (ii) O atoms.

(9) It is also further supposed that O_2 and CO molecules are mutually inert in flames, and that, before the latter can be oxidized, the O_2 must be resolved either into atoms or "activated" steam. Thus, we might have:

either (*a*) $CO + O \rightleftarrows CO_2$, *or* (*b*) $CO + OH_2 \rightleftarrows CO_2 + H_2$,

but *never* (*c*) $2CO + O_2 = 2CO_2$.

(10) Such a view would account for (*a*) the comparative slowness of the combustion of carbon monoxide, as illustrated by the slow rise in the pressure curve for the CO-air mixtures in our experiments; (*b*) the observed accelerating influence of both steam and hydrogen thereon; and (*c*) the fact that the "mass influence" of carbon monoxide upon the actual distribution of oxygen between the combustible constituents of a burning mixture

is proportional to the *first* power (and not, like that of hydrogen, to the *square*) of its concentration.

(11) The remarkable influence of hydrogen upon the rate of combustion of carbon monoxide in our experiments calls to mind the similar influence of steam first discovered by H. B. Dixon in the year 1880. In his later experiments upon the rates of detonation of ($2CO_2 + O_2$) mixtures containing varying proportions of steam, Dixon found that, starting with a well-dried mixture (firing at a pressure of 760 mm.), the rate increased, with successive additions of moisture, from 1264 to a maximum of 1738 metres per second for a mixture saturated with moisture at 35° C., and therefore containing about 5·5 p.ct. of steam. He also found that, on sparking a well-dried mixture of carbon monoxide (60 p.ct.), chlorine peroxide (29 p.ct.), and oxygen (11 p.ct.), though a flame was propagated through the gases, as much as 76 p.ct. of the original carbon monoxide may remain unburnt, showing that, while dry "nascent" oxygen may be reactive towards carbon monoxide, some other condition (*e.g.*, its continuous reproduction at a high enough temperature) is needed to make it fully effective. Our experiments seem to point to hydrogen being even more potent than its equivalent of steam as a promoter of the combustion of carbon monoxide (though this is a matter needing further investigation); and they suggest that its primary function is to resolve continuously the inert O_2 molecule into an "active" oxidizing condition (*i.e.*, into O atoms and "activated" OH_2), itself being continuously regenerated in some such manner as we have described.

(12) In addition to their bearing upon the theory of gaseous combustion, our results are of practical interest in connection with a question which has recently been much under discussion. In certain quarters it has become fashionable to assume that the relative values of different combustible gases are strictly proportional to their heats of combustion, irrespective of their chemical characters or modes of combustion. Such an assumption was, indeed, "tentatively accepted" by the Fuel Research Board in their report on "Gas Standards" in 1919, though its endorsement was qualified by the admission that "experimental proof" of it "is still incomplete." It seems difficult to reconcile it with the cumulative results of the last forty years of scientific research upon gaseous combustion, which have shown more and more clearly that the fundamental properties of the explosive mixtures formed by different combustible gases with air, arising from their own peculiar chemical characters and compositions, do affect profoundly their economic uses. The results of the present research emphasize the importance of the chemical composition of a combustible gas (or mixture) as a factor which cannot be disregarded when its economic value is in question.

Further experiments at high pressures are in contemplation to develop the matters dealt with in this paper; and it is intended also to make similar experiments at atmospheric pressure.

Our thanks are due (*a*) to the Government Grant Committee of the Society for grants out of which the cost of the expensive apparatus employed in the research has been defrayed, and (*b*) to the Salters' Institute of Industrial Chemistry for the Fellowship granted to one of us (W. A. H.) to enable him to devote his whole time to the work.

LONDON AND SOUTHERN DISTRICT JUNIOR GAS ASSOCIATION.

A Gas Regulation Act Evening.

There was a meeting of the Association last Friday evening at the Westminster Technical Institute, S.W., for the purpose of hearing an address on the "Gas Regulation Act and the Industry," by Mr. S. B. Langlands, Inspector of Lighting to the Corporation of Glasgow. It was a more or less informal meeting—presided over by Mr. F. A. FROST, of the South Metropolitan Gas Company—and was evidently as much enjoyed by the lecturer as by his audience. No set address had been prepared for the occasion; but Mr. Langlands clearly and concisely—and in a chatty manner, which held closely the attention of the meeting—discussed a question to which he has manifestly devoted a great deal of attention. As a matter of fact, it will be remembered, he read a paper on the same subject just over twelve months ago before the North British Association of Gas Managers [see "JOURNAL" for Sept. 8, 1920, p. 510].

Mr. LANGLANDS, in the course of his "talk," dealt with legislation prior to the Gas Regulation Act, and then with the Act itself. He referred to the attitude of the "JOURNAL" towards the new Act, and added the opinion that robust and informed criticism and comment never did anything any harm. Such criticism of the Gas Act would be useful. What, he asked, is an Act of Parliament? It is for the holding of the balance between right and wrong—to see justice done. All legislation is an interesting study. The first approach to Parliament so far as the gas industry was concerned was in 1809, when a Gas Light Company asked for incorporation. In the following year an Act of Incorporation was passed; and in 1812 a Royal Charter was granted, when the Company became the Chartered Gas Light and Coke Company. Subsequently, many undertakings secured powers, until in 1847 the Gas-Works Clauses Act was passed. Just at that period there were a great many consolidating enactments; and they were no doubt the work of some strong leading spirit. Then in 1871 there was an amendment of the Gas-Works Clauses Act, and so on until 1920. Speaking of Acts, one must not omit mention of the Sales of Gas Act, passed in 1859. It was a wonderful Act, which stood until the coming of the Gas Regulation Act in 1920; and some of them regretted its demise. It had many uses; and yet its time had gone past. The need for the 1920 Act was one of costs. Gas companies and corporations had given of their very best during the war; and the end of the war found them with a clear conscience, but an empty purse. Something had therefore to be done.

He invited his hearers to look at the gas industry for a moment as a whole. It was the product of steady work. There was no revolution; it was evolution. Among its builders were Murdoch, Clegg, Malam, Hawksley, Wyatt, King, Livesey, and Woodall. Take Livesey's sliding-scale. It was a wonderful thing; but even that was knocked out by the war. Gas shares became suspect. The 1920 Act stabilizes the industry again. He made it clear that he has no quarrel with the term "therm;" far from it. He welcomed the coming of the therm and of stabilized pressure. In Glasgow, they are in rather a peculiar position. They buy gas from the Gas Department, and do with it in the street lighting what they think fit. Naturally, therefore, he wants to buy a good product; and he thinks the therm value will assist him in his purchase. What he did join issue with was the method of charge; and he is still dissatisfied with this. It is a question of making-out accounts; and he contends that, these being days of simplification, a lot of book-keeping and similar work, which is of no value really, might have been saved.

As to the notification of thermal values, Mr. Langlands said he was pleased to see that Mr. W. E. Caton, of Oxford, had been warning people to be careful in the values that they fix. The need for this warning is self-evident. In a gas-works, so many things are apt to arise which one cannot foresee. Various accidents may happen to bring down the thermal value; and one needs a little margin to allow for these. The definition of composition and pressure is an important point. In Glasgow, the Electricity Department work with 250 volts; and if they go to 260, bulbs break, &c. If gas people change their pressure, these things do not happen; and in the past, he thinks, they have been too willing to take advantage of this liberty.

They had to congratulate themselves with regard to the carbon monoxide and inerts inquiries, which were conducted in such a fine spirit. The results were splendid. In 1898 the Water Gas Committee suggested 12 p.ct. limitation of carbon monoxide; and in this connection, Mr. Langlands recalled that on one occasion in those days he met Mr. James Stelfox, of Belfast, who he knew in his times of tribulation had to give as much as 50 p.ct. of water gas, because he had no room to do anything else. So this suggested restriction came to nothing then. In the inquiries which have just taken place, there was first a claim for no limitation; and one had a great deal of sympathy with this. Water gas is a very inviting proposition. It is easy of installation; the plant costs a great deal less than coal-gas plant; on a foggy day it is easily started-up; the labour is little; and the result is quick in the getting. One can therefore understand the desire of the gas engineer for no limitation. The figures brought over from the United States, and the opinions expressed by their friends over the water, were truly amazing; but the death rate was too high for the public conscience of Britain. Those present who had anything to do with the distribution of gas should read the report of the Committee carefully, and think, and think again, that defective forms of fitting may be a big source of evil. Altogether the finding of the Committee, that there should be no limitation in the meantime, was a very fair one. The call for a distinctive odour is a very good safeguard. As to the Incombustibles Committee, one does not really know what the future may hold for the industry; and the conclusion of the Committee was to leave them "on probation."

Referring to the provisions of the Act which allow gas companies to take certain powers which hitherto required a Bill or Provisional Order, Mr. Langlands declared it a wonderful charter. Many important things can be done now by applying to the Board of Trade. As to the Sales of Gas Act, the amendments are drastic, but all to the good. Speaking in his position as a Gas-Meter Inspector, he said the Board of Trade were helpful in every way, and showed themselves willing to make their regulations to suit the working of the inspectors of meters. They did not, however, do this without a great deal of scrutiny and careful inquiry. But once convinced, they did it well. He spoke in complimentary terms of the Manchester Meter Testing Station, and advised everybody who had the opportunity to visit it.

Reverting to Glasgow, he remarked that the lighting is done under a very old Act of 1866, which contains powers that might not be granted at the present day. This Act permits him to fix anything he likes to a person's walls, so long as it is in connection with a lighting appliance. "If," he said in conclusion, "you are going to start studying Acts of Parliament, begin by reading the introduction to Michael and Will on the 'Law Relating to Gas and Water.' It is a revelation in itself, and reads like a story."

DISCUSSION.

The PRESIDENT, after remarking upon the value of the address to the members of the Association, went on to say that, to his mind, it was very strange that such a drastic change from the usual methods

of procedure as had been brought about by the Gas Regulation Act should have been accomplished with so little dislocation in the cases where it had already been carried out. He was rather inclined to question the view which had been expressed, that the companies had put themselves to enormously increased expenditure in charging on the new basis. In the case of the South Metropolitan Gas Company, he had yet to learn that the expenditure in the accounts department was really any greater than upon the old basis. This was, of course, largely due to the efficient organization that was prepared beforehand. Everything had been carried out in a perfectly smooth manner without any difficulty, and, so far as he was aware, without any appreciable increase in the office staff. The change, at any rate, to the large gas undertakings, must be a welcome one; and industrial concerns of any size, where the expenditure on fuel, &c., was of any great importance in their productive costs, would have far less difficulty in comparing the charges for gas on the new basis with those for rival forms of energy. Something, however, on a large scale would have to be undertaken to remove the feeling of distrust which undoubtedly existed in the case of some of the smaller consumers of gas. Confidence must be the foundation upon which the future development of the gas industry was to be built.

Mr. J. R. GALE (North Middlesex Gas Company) urged that the average consumer did not care twopence about cubic feet, therms, or British thermal units; what he thought about were pounds, shillings, and pence. It seemed to him that the gas undertakings had rather overstepped the mark in connection with this new heat-value method of charging. The consumers did not understand it; and so they were suspicious. It was all very well to put an explanatory note on the accounts, if they liked; but the charge should have been left in cubic feet. It was an undoubted fact that there was a certain amount of suspicion about; and this, once started, was very difficult to allay.

Mr. S. B. CHANDLER (South Suburban Gas Company) contended that the Act had one very great advantage, in that it marked another step in the application of scientific methods to the gas industry, and brought them more in line with the electricity industry, which was scientific, and had always been so. Moreover, the Act gave them something wherewith to argue with their rival. For the first time in the history of the gas industry, they had comparable figures. The old cubic foot measurement meant little, if anything, to the average consumer. He was getting a cubic foot of something, but could not, without reference to the gas office, obtain any comparable figures with regard to what he was getting. Now, from the therm, they could not only themselves work out to a nicety comparable figures, but they could, in all honesty, go to a consumer and place before him these figures to prove their contentions. In the case of the modern gas-fire, and allowing a heat loss of 25 p.ct., he found that a therm was equivalent to 22 Board of Trade units. In the matter of power, taking 10,000 B.Th.U. per brake horse power generated, it would be found that a therm was equal to 7½ units. These were very useful figures for those on the district to keep by them. As to the gas to be supplied, the first point to be considered was the most economical method of manufacture. Economy in manufacture would produce the cheap therm. Secondly, they had to remember that the efficiency of gas lay in its application. One might have a very good gas put through the meter, and yet get a worse result from it than from a gas of perhaps two-thirds the calorific value. The South Metropolitan Company had done excellent work in this respect. They supplied a gas which was eminently suitable for their district, because they had burners constructed on scientific lines which gave their best thermal efficiency with this gas.

Mr. W. J. LIBERTY (Corporation of London) remarked that the South Metropolitan Company sold by the therm, and put a little explanation on the account, telling the consumer how to calculate the one basis of charge into the other. This, he found, was very simple indeed. With regard to the power of the Glasgow Corporation, under their old Special Act, to affix lamp attachments, &c., to walls of premises, he might say that in the City of London the Corporation had exactly the same power; and through this the authorities had been able to adopt central lighting, and give the people a shadowless city. The new Gas Regulation Act was a very fair one all round; and the Board of Trade were interpreting it in a very fair manner. He drew attention to the provisional prescription which had been issued by the Gas Referees under the Act, for the Aldershot Gas, Water, and District Lighting Company [as reproduced in the "JOURNAL" for the 16th inst., p. 487], and pointed out some of its features.

Mr. J. HEWETT (South Metropolitan Gas Company) said that, of course, those people who knew most about the matter were already in possession of the facts of the case; but the gas consumer, who naturally was not in the habit of reading Acts of Parliament, very often remained in the dark. The provisions they were now discussing had been in force for a very short time; and many people were ignorant of the real meaning of the changes that were being made. More education of the consumer might be one of the ways of combating this. The whole thing must be explained thoroughly to them. Let the people they were supplying know in a straightforward manner what they were up to. It would clear the air wonderfully. His own Company had done a considerable amount of work in this direction.

Mr. D. J. WINSLOW (Lea Bridge District Gas Company) said that no doubt there were great benefits accruing under the Act both to the gas suppliers and to the general public. The question of the accounts seemed to him to be a simple matter. They would in course of time be quite accustomed to speaking of therms; and with proper service by the gas company, the consumer would learn to appreciate the heat-value basis.

Mr. LANGLANDS, in reply, said that he, too, was altogether in favour of the therm. His criticism was purely and simply on the little matter of the account which was handed to the consumer. There was some more work entailed; and somebody had to pay for this little extra work. His cry was, "Simplify, simplify." They could not afford that suspicion should exist. By all means, educate as much as they could; but they should not throw things at the consumer without any warning. As a matter of fact, they were giving the consumers a stabilized thermal value and pressure. It was these two things which the consumers needed; and that was why he was so thoroughly in favour of the therm. Under the new Act, the consumer would have a sure thing all the time. He was in hearty agreement with the South Metropolitan scale of values. There it was going to be a process of evolution. He had only praise for that Company from the gas consumers' point of view.

Mr. LIBERTY, in proposing a hearty vote of thanks to the lecturer for having come so far to address them, said that Mr. Langlands was a man of wide experience who had given a lot of time and thought to this important question.

Mr. W. L. WESTBROOK (North Middlesex Gas Company) seconded the vote, which was cordially passed.

Mr. LANGLANDS, in acknowledgment, remarked that if any of the members at any time went to Glasgow, he would be delighted to see them, and would show them what it was hoped to make one of the most interesting testing laboratories.

THE VISIT TO THE DAVIS COMPANY'S SHOWROOMS.

The HON. SECRETARY (Mr. George Winslow) announced that the visit to the Davis Gas-Stove Company's showrooms, which had been fixed to take place on Dec. 2, had been postponed until Friday, Dec. 9, owing to the absence abroad of Mr. Davis. A very interesting programme has been prepared, including a short address by Mr. Twigg and various demonstrations.

A DISCUSSION EVENING.

The HON. SECRETARY also drew attention to the fact that on Friday evening, Dec. 16, there is to be a discussion evening, when an instructive meeting is anticipated. Three subjects will be introduced—"Notes on the Composition of Various Grade Gases," by Mr. T. V. Johns (Richmond); "Some Notes on Ascension Pipes," by Mr. F. J. Pearce (North Middlesex Gas Company); and "Notes on Coke-Handling Plant," by Mr. L. Lacey (Gas Light and Coke Company).

MIDLAND JUNIOR GAS ASSOCIATION.

Visit to the Pleck Gas-Works, Walsall.

On Saturday about sixty members of the Midland Junior Gas Association visited the Pleck Gas-Works, Walsall. In the absence of the President (Mr. W. Batt), Mr. C. F. W. RENDLE, the Senior Vice-President, was in charge of the party.

The members were received by Mr. Howard Tucker, the Deputy-Mayor and Chairman of the Gas Committee. The party was then split up into two sections—Mr. F. Davies (Assistant Manager) conducting one, and Mr. J. W. Wilson (Works Foreman) the other.

The chief point of interest was the up-to-date vertical retort installation, comprising five beds of Woodall-Duckham continuous vertical retorts, having a capacity of 100 tons per day. The plant was seen in working order by the members. The cleanliness of the plant, and in fact of the works generally, was a very noticeable feature.

In turn the sulphate, benzole, carburetted water gas, and other sections of the plant were inspected.

THE VISITORS ENTERTAINED.

At the conclusion of the tour of inspection, the members were entertained to tea in the works offices, where Mr. Tucker welcomed them, and apologized for the absence of Mr. B. W. Smith, the Engineer and Manager, through indisposition.

Mr. C. F. W. RENDLE (Redditch) proposed a hearty vote of thanks to the Chairman and members of the Walsall Gas Committee for their kind permission to visit the works, and for their hospitality. He greatly appreciated the trouble taken by the Chairman in assisting to conduct the party round the works, and also to those gentlemen who had helped in making the visit such an instructive and enjoyable one. It was gratifying to see so many members of the Association present.

Mr. L. H. THOMAS (Birmingham), in seconding the vote of thanks, said the visit had been a great success. Perhaps one of the most noticeable features was the cleanliness of the works.

The vote of thanks was carried with enthusiasm.

Mr. TUCKER, in replying to the vote of thanks, said that while the works plant was of an up-to-date character, much still remained to be done in the way of final tuning-up. He remarked that associations such as theirs were valuable institutions, as they afforded members ample opportunity of assimilating knowledge, which should all tend towards the progress of the gas industry. In mentioning the fact that he was also a member of the Walsall Electricity Committee, Mr. Tucker said that great strides had been made in Walsall as regards electricity for lighting purposes; and it was up to the Gas Department to do all in its power to endeavour to make up this serious loss of output. With this end in view, the Gas Department were now supplying cookers and gas-fires to consumers on hire terms.

Mr. F. DAVIES (the Assistant Manager) said it had given them great pleasure to show the members round the works; and if the visit had been instructive and enjoyed, he thought they had been amply repaid.

Mr. John William Crosthwaite, of Harrogate, for many years Chairman of the Crossgates Gas Company, has left estate of the gross value of £16,661.

Next Wednesday afternoon (Dec. 7) the members of the Manchester and District Junior Gas Association are visiting the Grappenhall works, Warrington, of the Richmond Gas Stove and Meter Company, Ltd. After an inspection of the works, a paper will be read by Mr. J. H. Clegg, of Burnley, on "Distribution and Commercialism."

PUBLIC WORKS, ROADS, AND TRANSPORT CONGRESS.

INSTITUTION OF GAS ENGINEERS' DAY.

WE conclude to-day the report of the proceedings at the day's conference, on Nov. 18, arranged by the Institution of Gas Engineers in connection with the Public Works, Roads, and Transport Congress at the Royal Agricultural Hall, Islington. The whole of the day was devoted to public matters of importance to the industry. Four papers were presented; and of these the two submitted at the morning session were given last week, while the afternoon's proceedings are reported below. The chair was occupied by Mr. THOMAS HARDIE, the Deputy Chief Engineer of the Gas Light and Coke Company, and President of the Institution of Gas Engineers.

COAL TAR FOR ROAD WORK.

By H. W. JAMES, Manager of the Tar-Works of the South Metropolitan Gas Company.

When the author was invited to contribute a paper, it appeared to him that so much had already been said and written on the subject with which he was asked to deal that there would be great difficulty in placing before his hearers anything that had not been previously discussed at length, and possibly even *ad nauseam;* but, after considering how rarely the tar distillers have dealt with the matter from their standpoint, he felt that possibly he might be excused if he framed his paper on such lines as, to the best of his ability, to make good this omission.

It is important to bear in mind that coal tar is a product of the carbonization of coal in gas-works or coke-ovens, and that the distiller is necessarily compelled to prepare the several grades of road tar from the crude material that is sent in to his works. If his raw material be of such a nature—*e.g.*, very rich or very deficient in free carbon—that he cannot bring the refined product to conform with the specifications laid down, the local highway authority must either make the best of it, or import tar from some other district, involving the additional expense of transport by rail or road. For this reason, those to whom it falls to draw-up provisions relating to the supply of this material are well advised to make them as elastic as possible. Only a few years ago a large and important number of makes of coal tar would have failed to fall within the limits generally laid down for free carbon.

The expression "free carbon" is one that might well disappear. Even if its application were restricted to its carbonaceous constituents, it would be a misnomer; but inasmuch as it may well embrace a very considerable amount of mineral matter, usually determined as ash, it is obviously high time that a new term was adopted. When testing for free carbon by the employment of organic liquids, it has to be remembered that it can be more or less freed from bitumen by quite a number of solvents, some of which will remove compounds that are insoluble in others. The use of a prescribed amount of a single solvent—say, benzole—would probably be far more satisfactory when analyzing road tars, and the product could then be more accurately defined as "insoluble in benzole." Coal-tar chemists would doubtless welcome this simplification.

A great deal has been said and written about "free carbon;" and it has been condemned again and again as a deleterious constituent of tar. There is, however, no doubt that it serves a very useful purpose. In pitch it certainly has the effect of rendering the product tougher, and therefore less brittle; and, having regard to the well-known and beneficial influence of finely-divided powders (known as "fillers") when incorporated with the tar, in rendering it less susceptible to the extremes of climatic temperature, one is led to conclude that the insoluble matter may itself have a similar tendency.

Observers have from time to time testified to the justice of this conclusion; and it has been definitely reported that roads built-up with the assistance of a tar deficient in insoluble compounds have proved unsatisfactory. The use of such a tar for grouting has resulted in a road that is far too sensitive to the heat of summer, and that has remained in what has been described as a "floating" condition for a considerable period; while it has been recorded that, as the lack of insoluble matter has been made good in the course of time by the penetration of grit into the tar while in position in the road, there has been a noticeable improvement with age. The real difficulty here is to discover the limit beyond which this constituent of tar becomes a disadvantage.

More or less closely bound-up with the question of insoluble matter is the procedure known as "cutting-back"—that is, the addition of tar-oils for reducing the hardness of pitch or the consistency of tar. The most important point here is that the insoluble matter shall not be precipitated. To take an extreme case, the addition of a mobile liquid, such as coal-tar naphtha, to tar will precipitate the insoluble matter, and if the mixture is allowed to stand for some time, a further appreciable quantity is thrown out of solution. A similar action occurs when tar-oils of comparatively low boiling-point and low viscosity are added, though the precipitation is very much slower than is the case with naphtha. The higher the viscosity of the added oil, the greater will be the tendency of the insoluble bodies to remain in suspension in the mixture. Now, for any given tar one can generally lay it down that the higher the boiling-points of the oils distilled from it the higher their viscosity, and also the higher their specific gravity; and it would therefore seem fairly obvious that the higher the distilling points and specific gravities of the oils used for cutting-back, the less tendency will there be for insoluble matter to be thrown out of suspension, and therefore the better will be the product obtained. Those who have observed the nature of the oils that pass over at the extreme end of a distillation of tar must have been struck by the very strong agglutinating powers that they possess. In making a medium coal-tar pitch, such oils are, of course, distilled out; and it seems only right that, when cutting-back for road work, these highly viscid liquids should be returned to the pitch, rather than that their places should be taken by oils that may be far more mobile, and therefore seemingly far less satisfactory.

For this reason, when drawing-up specifications for tar oils that are to be used for thinning tar or softening pitch, no upper limit should be quoted for either their distilling ranges or their specific gravities. There is considerable risk that when a tar or pitch has been cut-back with too mobile an oil, there will be penetration into the road on the part of the liquids, while the insoluble constituents of the tar will tend to remain as an external coating on the road metal. This tendency will be all the greater if the stone employed be of a permeable or semi-permeable character. A similar argument will apply to the use of tar at high temperatures for surface treatment, especially where a penetrable stone forms the aggregate; and it seems that, though it is necessary to apply tar sufficiently hot to render it comparatively limpid, there may nevertheless be a tendency on such roads for the liquid and soluble constituents of the tar to penetrate, while the insolubles are deposited on the surface—if the temperature at the time of application be too high. The author has been in contact with instances of such a deposition, where the explanation of the trouble appeared to be as stated; but it is a point on which investigation would be very useful. In the process of cutting-back, it is really doubtful whether the best results are obtained by the addition of oils; and at the works of which the author has charge he has, whenever possible, made it a practice to use refined tar of low consistency for this purpose.

Another property of coal tar that is to a certain extent associated with its content of insoluble compounds is what is unfortunately termed its "viscosity." The word "viscosity" would appear to be quite out of place when applied to a mixture like tar. Its application to tar oils is, of course, perfectly legitimate, but its use should surely be restricted to liquids or semi-solids of a more or less homogeneous nature. Even though employed when dealing with the properties of emulsions, its application is hardly justifiable in connection with coal tar, where a comparatively coarse solid is in suspension. There does seem to be a tendency at last to substitute for it the word "consistency"—a term that is not scientifically defined, so far as the author is aware, as is the case with "viscosity"—though the very vagueness of the former (albeit its meaning is actually well understood) makes it far preferable when dealing with a heterogeneous mixture such as that we have at present under consideration.

Some years ago—especially before the tar treatment of roads was developed—it was customary to refer to the various grades of refined tar according to their specific gravity; this property being supposed to indicate the extent to which the partial distillation had been carried during the process of preparation, and consequently being regarded as a measure of the consistency of the material. While this is all very well in the case of those products resulting from any one type of crude tar, it is practically valueless when comparing refined tars obtained from the raw material resulting from carbonization of various kinds of coal under all sorts of conditions. In the very early days of road tar, one was brought into contact with tars from all over the country, which, though prepared to a certain definite gravity, differed very considerably in consistency, and therefore in their value as agglomerating agents; and it seemed obvious that, if the right grades of tar were to be secured for such objects as surface treatment, tar macadam, or grouting, the method of defining their grades by their specific gravity would have to be abandoned, and some form of test for consistency adopted.

It would be quite possible to make some determination of this property by employing one or other of the several well-known viscometers; but their use seemed to be hardly satisfactory for several reasons—one being that the presence of solid insoluble particles in suspension would tend to interfere with results obtained by flow through a narrow opening. Another would be the trouble of cleaning tar out of the apparatus after each determination; while the cost of the viscometers and the skill required in manipulating them all pointed to the desirability of a less costly instrument that could be cleaned rapidly, and which could be used

by any man of average intelligence with very little instruction. Experiments were made with instruments which would indicate roughly the degree of consistency of the tar by the rate at which they became immersed therein; and eventually it was found that glass hydrometers of a certain pattern and size, and covering a certain range of density, would serve the purpose admirably.

Testing the Consistency of Tar.

Even though these instruments varied somewhat in their measurements, they proved very useful as a temporary expedient; and tar supplied according to grades of consistency as determined by this means gave satisfaction—roads constructed therewith as long ago as 1909 being still in excellent condition. Though this procedure for testing the consistency of coal tar is not to be regarded as of great accuracy from a strictly academic standpoint, it nevertheless served its useful purpose very well, though it was at once seen that a standardized immersion consistometer would be far preferable to the hydrometer, which, as above stated, varied somewhat in weight, size, and other particulars, and, being made of glass, suffered the additional drawback of fragility. Ultimately the well-known standard instrument of the late John Hutchinson was developed. This was made in metal, and gave approximately constant readings when tried repeatedly on a given sample. When employed as a testing instrument, observations of the rate at which it sinks at a definite temperature (77° Fahr.) give excellent indication of the consistency of the tar. The instrument very modestly made no claim to determine viscosity in scientific units; and it was known merely as a viscosity gauge, though the author of this paper would prefer to see the word "viscosity" replaced by "consistency."

The advantages attached to the employment of this instrument are that it is not fragile, that it is easily cleaned after use, that any man possessing average common sense can rapidly learn how to use it, and that it is comparatively cheap. A further and important consideration is that surveyors and engineers in widely-separated districts can readily compare notes by reference to a standardized instrument such as this. The disadvantages are possibly two in number: First, that a large quantity of material (nearly half-a-gallon) is required for carrying out the test; and, secondly, that the readings obtained are not in terms of any scientific unit. The author must ask indulgence in dealing somewhat at length with this instrument; but in spite of the various reasons against its employment, it has served its purpose so well in his own laboratory that he may perhaps be excused for a little superabundance of enthusiasm. It can generally be accepted that the simpler and easier a test is, the more attractive it should be considered, and that the infliction of unnecessarily complicated methods should be avoided. Where, as is the case with the consistency of road tar, an approximate figure serves the purpose to every satisfaction, it is a sheer waste of brains, time, and money to go to degrees of accuracy that are not required.

It may be said that all tar refined for road work in the tar distillery for which the author is responsible has been for many years prepared strictly on a consistency basis, with the result that complaints are practically unknown. He has at various times had samples of tar from other sources submitted to him for examination in cases where unsatisfactory work has resulted; and almost invariably the causes of failure have been either the presence of water or (and especially where the trouble has been in connection with constructional work) faulty consistency. It does seem that if contracts for road tar were arranged on a definite grading with reference to this property, successful work would be far more easily attained.

Water as an ingredient of tar is practically fatal to success; and as this must be so well known to all engaged in road engineering, it would be waste of time to deal with this cause of trouble at any length, were it not that one cannot too often, or too emphatically, condemn the use of crude tar (containing water and ammoniacal compounds), which is utterly discredited as an adhesive binding agent, and involves the very serious risk of polluting adjacent streams, watercress beds, &c.

Specific gravity is a property that has already been mentioned; and it merely remains to be said, so far as the tar distiller's point of view is concerned, that, whereas there seems to be but little object in imposing any upper limit to the density of tar, a lower limit might well be insisted upon in order to preclude the delivery of tars that are exceptionally rich in paraffinoid compounds. These are the characteristic bye-products of certain methods of coal carbonization; and they may be found of less value to the road engineers than ordinary coal tar.

The utilization of pitch for grouting, &c., has, in recent years, given rise to a new mode of testing this product. The real aim should be to secure pitch that is of the grade (of what is customarily termed "hardness") best calculated to withstand local climatic conditions; and for this reason one would be inclined to conclude that a determination of the temperature at which it becomes really soft would afford the best indication of its fitness for the work. If this is so, it is difficult to realize why a new and unwelcome complication should have been introduced into pitch specifications, when a knowledge of the fusing-point should not merely suffice, but should actually be more acceptable to the engineer, inasmuch as the meaning of a definite temperature of "fusion" is so easily grasped. The penetrometer is no doubt an excellent instrument for the examination of asphaltic compositions; but it is by no means easy to understand its value for testing coal-tar pitch.

Defining the Word "Bitumen."

The two most important publications specifying the qualities of various grades of tar for use in road work are probably those issued respectively by the Ministry of Transport and by the British Engineering Standards Association. The latter proceeds farther than the former, in that an attempt is made therein to define the word "bitumen." The result is most unfortunate, and is nothing more or less than the perversion of a well-known term as regards its application in a particular industry. The principle that has been adopted is that those particular types of bituminous binding agents which are, in the view of the Committee, best suited for road work shall alone be classed as bitumen in the future. This attitude is quite unjustifiable, and is very much to be deplored. One can hardly imagine scientists accepting such a definition, based as it is on the use of the material in one industry alone. If it is generally accepted that a committee may lay it down that only those bitumens considered by them best for their work shall be called bitumen, a precedent is thereby set-up which may justify the members of any industry in similarly imposing a nomenclature based on their requirements.

It would be quite in order for the block-fuel manufacturer to exclude from his definition of bitumen everything but the varieties of pitch that satisfy him; the user of bituminous coal could adopt a definition of coal that would throw out all non-bituminous types; and the instrumental musician, who has too often but little sympathy with the vocal art, may even frame his definition of music in such a manner as entirely to exclude the latter. This is admittedly carrying the argument to its extreme; but it serves to show that, if it be granted that any body of men may handle a generic term in such a way that they can apply it just to those particular classes of the genus that they fancy, the result will be endless confusion. Bitumen was considered by that great geologist, Sir Charles Lyell, to be typified by the black substance that oozes from Newcastle coal when it burns. Coal-tar chemists will probably mutually agree in regarding their pitch as consisting of bitumen *plus* free carbon (or insoluble matter). If the Sub-Committee's definition of bitumen is generally approved, and is to apply in future only to substances that occur in the natural state, or as residues from the treatment of asphaltic oils, what new word are we to invent that shall take its place as a generic term, and include coal tar and the several other forms of bitumen? The bitumens have already been classified according to their origin; and if the Committee choose to say that those bitumens that are found in the natural state or obtained as a residue from asphaltic petroleum are in their opinion to be grouped separately as regards their value for road work, on account of their possessing certain properties, their action would at least be logical. But it is surely inadvisable that, in order to avoid confusion in the selection of bituminous material, a deliberate confusion should be made, and made quite unnecessarily, in the use of the term "bitumen."

The writer trusts that this paper will not be regarded in any way as an attempt to criticize destructively and in detail the provisions of the several coal-tar specifications that have been issued by the above and other authorities from time to time. This is not the occasion for such criticism; and in any case the author, whose experience has been chiefly confined to the handling, preparation, and testing of tar and its products in a tar-works, could hardly presume to lay down the law with regard to the practical application of road tars. The object he has had in view is to bring home the advisability of co-operation between distiller and highway engineer, to suggest broad lines along which specifications may be based, taking as a foundation for success absence of water and the grading of tar according to consistency, and to indicate where he feels simplification and improvement are advisable.

DISCUSSION.

The Chairman remarked that the paper they had just heard was on a subject which was of particular interest to those attending the exhibition. It was impossible to walk round without being struck by the importance of tar in road work. Perhaps Mr. Butterfield would open the discussion.

Mr. W. J. A. Butterfield said he felt some diffidence in doing so, especially as he could not deal with the paper in a critical spirit, because he agreed with nearly everything which Mr. James had put into it. Taking his last argument first, he entirely endorsed the author's contention that the word "bitumen" should not be restricted, as the Nomenclature Committee of the British Standards Association proposed to restrict it, to natural products. It was tearing the word away from its natural, and much more comprehensive, application. He spoke feelingly on this point, because he was a member of the Committee, and put in the reservation that he could not agree with the proposal to limit the use of the word bitumen as it had been proposed there that it should be limited. As regarded the use of the term "free carbon," one might quite well say that it was easy to employ a better one; but it had come so generally into use, and it was so fairly well understood what it meant, that he thought the use of any number of words, such as "insoluble in benzole," became cumbersome in comparison. The very general practice, he believed, was to put the words "free carbon" in inverted commas; and then anyone realized that it was not pure carbon, but was the natural filler of coal tar. As regarded its function in coal tar, it served exactly the same purpose as the fillers in asphalting materials; and he quite agreed that a lower limitation was necessary, if the tar was to have its proper cohesive character. This was recognized by the Road Board Advisory Committee. The first Road Board specification had no lower limit; but later on a limit was put in, that the "free carbon" should not be less than 12 p.ct. One might well say this was too low; and on the whole

he agreed. But then they were dealing with the whole matter of making a specification which would include the bulk of the tar produced in different parts of the country, so long as it was suitable for road work. It was almost impossible to draw-up a specification which would admit all the tars that were suitable for road work, in whatever part of the country they might be produced, and yet to make it so that coal tars from certain parts were not admitted which it was really undesirable should be admitted. What was wanted was a separate specification for the tars produced in different districts, or possibly by different processes. For instance, Mr. James spoke of the viscosity in relation to the "free carbon." This was a totally different relationship in the tars of the London districts and in those of (say) the West of Scotland. In the West of Scotland, if they had a tar with 12 p.ct. of "free carbon," it was far more viscous than a London tar with well over 20 p.ct. of "free carbon." This dealt, he thought, with one general criticism of existing specifications. What was now the Ministry of Transport specification, adopted by the British Engineering Standards Association, was sufficiently comprehensive to deal with all the tars from different parts of the country. It was well recognized that it was not ideal; and if one were drawing-up a specification for surveyors' use with only South of England tars, one would alter it materially. The suggestion that freedom from water and consistency would practically suffice for a specification, he thought, also failed to meet the varying conditions in different parts of the country. For a tar of the same consistency produced in the London area as one produced in the Glasgow district would be totally different in character, and its durability as a road coating would be entirely different. On the whole, though it was more troublesome, one did better to take account of the proportions of "free carbon" and the proportions of oils, rather than depend merely upon the readings of a viscosity gauge. He fully agreed with the author in preferring the use of the word "consistency" to "viscosity;" and he wished to add his appreciation of the value of the late Mr. Hutchinson's viscosity gauge. To surveyors who would take the trouble to use it, or to foremen who could be trained to do so, it was very valuable indeed in controlling deliveries of the same class of tar. The only real objection to it was that it needed, as Mr. James had pointed out, a rather large quantity of tar; and it was somewhat difficult to bring this large quantity to the particular temperature required, and to maintain it at this point—not to exceed or to fall short of it when making the readings. With regard to the function of "free carbon," to which he had already referred, undoubtedly if a tar was deficient in "free carbon," and therefore in cohesive and adhesive properties, the best way to make up for this loss was to blend with the tar some coal tar pitch containing a high proportion of "free carbon." He had frequently recommended surveyors who had been in trouble with these very thin tars in different parts of the country to get over it by obtaining some pitch from distillers using tar which contained a high proportion of "free carbon," and to blend this pitch with their own tar. Next to that, the best way of dealing with these low viscosity, thin tars, the production of which was increasing largely, was to incorporate some other filler—such as fine limestone dust, just as was done in incorporating a filler with natural asphalts. He thought that somewhat on the same lines came Mr. James's suggestion that tar was much better than oils for breaking-down pitch when necessary. He was not sure that the author was quite right in suggesting that the fusing point was a sufficient criterion of the value of pitch for grouting work, for the reason that pitches which might have the same fusing point might be very much more or less brittle at ordinary temperatures, according to their other characteristics. For instance, a low "free carbon" pitch would be very much more brittle at low temperatures when used for grouting than one having the same fusion point which contained a higher proportion of "free carbon." The opportunity which had been given them of discussing this paper was one he greatly appreciated.

Mr. F. E. BRISTOWE (London) said he found himself in rather a difficult position, because, though he claimed to know something about road construction, at the moment he entirely agreed with what had been said by Mr. James and Mr. Butterfield. Therefore if he made any suggestions—as the surveyors did not seem inclined to speak—it would be from the point of view of his experience in working with them. The difficulty, or one of the difficulties, that he had come across had been that of the standard of efficiency. If Mr. James's suggestions could only be adopted in some way, so that there would be a means of arriving at what the standard of efficiency should be, a great deal of the trouble that at present arose would be obviated. The average surveyor, so far as he knew, had had more or less experience of tar, according to the uses and exigencies of the district he had to administer; and to this extent the surveyor was probably very much controlled by the supplies obtainable in his area, on the lines indicated by Mr. Butterfield. But, in addition to this, these conditions would vary according to the use to which it was desired to put the material. He had come across many instances of the receipt of furious letters on account of material supplied which was stated to be totally unsuited to the purpose for which it had been sent; and on going into the matter, he had found that the difficulty arose from the foreman or the man in charge of the depôt making a mistake between the material sent for grouting and that intended for spraying. If the supplies could be so arranged that there would be no question as to what the standard of efficiency required should be, many of their troubles would be overcome. He would have liked to hear a little more on another side of the question, with regard to which a strong line should be taken—more especially as the Fisheries Board and fishermen generally were just now bestirring themselves so much. It should be distinctly understood that no local authority in any circumstances whatever should be allowed to use crude tar. ["Hear, hear."] Crude tar could only lead to great waste. The authorities were, in the first place, buying a certain proportion of water which was no use for their roads; and in evaporating this water, they were losing other volatile materials which, under scientific treatment, might be put to a useful purpose. Added to this, crude tar had proved itself to be the worst enemy the road maker could have, and had led to an enormous amount of trouble in connection with roads that were anywhere near fishery streams or watercress beds, &c. He contended that if the tar was properly prepared and properly applied, and suitable precautions were taken, there was no reason why a tar-treated road should not be just as safe alongside a stream as any other. Of course, if the surface was waterproofed, one had to make provision for the detritus which the surface would collect, and which a storm would otherwise wash into the stream. This had nothing to do with the tar, but with the old system would have got incorporated in the road, and so would not have been quite so dangerous as the top of a waterproofed road. There had been certain reports on this subject lately; and it seemed that it was quite simple to arrange some sort of filtering or interception which would prevent this material going into the stream at all. It was incumbent upon those who had to deal with this question to take proper precautions. The public had a right to use the road, and had to pay for it; and they were entitled to receive some sort of result. It seemed rather hard if a man should have to have his garden spoiled on one side of a road because on the other side there happened to be a fishery stream which he was not allowed to use. He hoped that the main object of Mr. James's paper would be followed up, so that as far as possible matters might be simplified for the benefit of all concerned.

Mr. R. G. KIRTON (Perth, Western Australia) said that, for the most part in his country, they had been "barking up the wrong tree," and they had not got proper results. So he had come over here to seek information on the subject of road treatment. In using tar for the construction of roads in Australia, they were up-against the difficulty of it? heat resisting properties. What was the best way to meet the problems Some people had told him that the addition of Portland cement was a solution. When making a tar road for a temperature averaging 20° to 30° higher than in this country, it was necessary to add something to make the road more heat resisting. In connection with the specific gravity of tar, they had to take into account that it was a liquid with suspended solids. It was impossible to ascertain the true specific gravity of a material like this on any float principle. He would therefore like some information as to what co-efficient should be used to compensate for the solid material which was suspended in the liquid. Realizing that tar was composed of a liquid and a solid, they had a very important consideration to take into account—namely, its absorption properties. The different aggregates that were used with it he found, with one or two exceptions, were very absorbent. A well-known engineer in London had told him that to make the best road one did not want the hardest aggregate, if it was going to be tar macadam. If they used a hard crystalline granite, there was very little absorption of the tar, and it did not make a homogeneous mass; whereas with the use of an aggregate which would absorb tar much more freely, when the traffic came along, the mixture went down into a compact mass.

Mr. W. G. ADAM (Beckton) said he was the representative of probably the largest tar distillers in the country; and they made the largest quantity of road tar. He agreed with almost everything Mr. James had said. One point which he thought he might have emphasized was that the original specifications for tar were got-out in agreement with the tar distillers. It was only recently that the distillers had not been represented on the Committees which made out the specifications. He believed that, had they been represented, the word "bitumen," to which everyone objected, would have been left out of the specification. As regarded "free carbon," the American specifications went even further than specifications in this country. The highest limit in America was 25 p.ct. of "free carbon." To illustrate the quantities of tar being used in America, he might say that about two months ago he was informed by the largest tar distillers over there that up to August they had booked orders for over 50,000,000 gallons of road tar. The total consumption in America was probably in the neighbourhood of 80,000,000 gallons a year. He also agreed with the author that the word "viscosity" should be dropped, and "consistency" take its place. He might say that all the road tar made by the Gas Light and Coke Company had for a number of years been tested by the Hutchinson instrument. They had found it extremely useful for the control of tar in manufacture. It was an instrument which could be used by practically anyone who had received a few simple instructions. The use of road tar in this country had very rapidly increased. From his own Company's figures, they knew that since the war it had been almost double what it was in years before 1914. Prior to the war, they used to make about 2,000,000 gallons a year. During the war he believed they were the only people to supply it to the Government; and they sent something like 5,000,000 gallons out to France. This year they had delivered a quantity of about 4,000,000 gallons; and next year they hoped to do still better.

Mr. H. F. GULLAN (Belfast) said he was not a tar distiller, but a road maker. The paper was most opportune. In Belfast they had had, since the coal strike, a very considerable amount of trouble in securing what in his opinion was a standard tar—and when he spoke of a standard tar, he referred to the Road Board's specifications Nos. 1 and 2. These, as they were all aware, were distinctive—one being used for tar grouting, and the other for tar spraying. The trouble he had met with had been the question of "free carbon"—a difficulty in obtaining the required percentage. The distillers had met every objection to the results of a test by the statement that the filler was of very little value in regard to tar work. From his own practical experience, however, he entirely endorsed Mr. James's remarks with reference to "free carbon." It toughened the tar; and they obtained a far superior tar macadam with a good percentage of "free carbon." The John Hutchinson instrument was of the greatest value to the road constructor. With his own tar macadam plant, the Hutchinson instrument was used daily by the foreman, who thoroughly understood it. The instrument was most valuable as a ready means of ascertaining the quality of tar as it arrived in bulk. The trouble he found was that it was not the foreman generally who made the mistake in sending out the tar. Mr. Bristowe said surveyors did not know the difference between light and heavy tar. He (the speaker) had not come across such surveyors. It would be remarkable if they did not understand this difference at the present day.

Mr. BRISTOWE: I did not say that surveyors did not know the difference, but that there was very often a confusion in the use of them—a very different matter.

Mr. JAMES, in reply, said the only point he needed to deal with in

Mr. Bristowe's remarks was where he assumed that he (Mr. James) wanted to make consistency and lack of water the only basis upon which tar should be valued for road work. The fact was that the great and important properties were freedom from water and consistency; and specifications should be built-up round these two properties. Mr. Bristowe had rubbed in well—and they could not be rubbed in too well—the disadvantages applying to the use of crude tar, which should never be employed for road work. The chief trouble of the gentleman from Australia seemed to be resistance to high temperature. It was rather difficult, without knowing the source of his tar, to answer his question. With regard to what had been said as to testing for specific gravity, what he (Mr. James) had particularly in mind was consistency. A few days ago, he came in contact with a gentleman who laid a road in 1909, when "free carbon" was as much as 30 p.ct. and more in tar; and this road was to-day in a splendid condition. This showed that the upper limit in present specifications was too low. The last speaker had said that he had a difficulty in getting the right percentage in "free carbon." It depended very largely upon the source of the tar. Probably, it would be necessary to make up the deficiency by adding artificial filling agents. He had seen it stated that powdered slate would make an excellent filler. It might do so; and experiments should be carried out to determine its value for combining with tar.

The author was cordially thanked for his paper.

THE REDUCTION OF ATMOSPHERIC POLLUTION BY THE USE OF GASEOUS FUELS.

By DR. J. S. OWENS.

The impurities which cause the greatest amount of inconvenience and injury to health consist of solid particles, which, by virtue of their small dimensions, are distributed widely through the atmosphere from their source; and the chief source of such is the smoke of burning coal. It is unnecessary to dwell upon this, beyond saying that the existence of smoke from coal-fires implies the burning of raw bituminous coal in an imperfect way. Any factor which reduces the number of fires burning smoky coal will naturally reduce the amount of atmospheric pollution.

I do not propose to deal at length with the question of relative economy as between gas-fires and coal-fires for domestic or industrial purposes. This aspect of the question was fully discussed in Sir Dugald Clerk's address to the British Commercial Gas Association in 1919. He expressed the view then that "taking all coal uses, gas for domestic purposes would reduce the consumption of solid coal by one-half." This is an economy of coal which we cannot afford to neglect, as our stocks of coal in the earth will not last for ever.

Aside from the other important questions, such as economy and the hygienic aspect of gas heating, both of which have been fully dealt with, the chief question which I propose to consider here is whether any effect can be traced upon the amount of impurity in the air of our cities owing to the increasing use of gas for domestic and industrial purposes. In order to consider this question, I propose simply to examine the facts of the case—that is, taking certain cities for which sufficient data are available, both as to the amount of atmospheric impurities and the extent of the use of gas, to consider whether these facts are consistent with the suggestion that the extending use of gas during recent years has brought about an observable reduction in the amount of atmospheric pollution. For this purpose, we will examine the data for the two largest cities in the kingdom—that is, London and Glasgow. In both cases the data on atmospheric impurities are particularly full, and observations have been continued with little interruption for several years, the results of which I have now before me. I have also obtained, through the kindness of the British Commercial Gas Association, such figures as were available relative to the increasing use of gas appliances. It will, therefore, be of interest to associate these two sets of data, and examine the result for any relationship such as above suggested.

I propose to examine the figures for the six winter months only, when artificial lighting and heating for domestic purposes are in full operation. Further, as the special impurities contributed by smoke from fires, which might therefore be expected to show the greatest sensitiveness to any diminution of smoke-production, are total impurity, carbonaceous or sooty matter, tar, and sulphates, the deposits of these have been tabulated separately. Soot, it is well known, is derived solely from smoke; tarry matter and sulphates may also be regarded as practically entirely derived from coal smoke.

We will now consider the cases of London and Glasgow, the figures for deposit in which cities are shown in Table I.

TABLE I.—*Mean Monthly Deposit in Metric Tons per Square Kilometre for the Six Months ended March* 31. (*For English Tons per Square Mile, Multiply by* 2·56.)

—	1915.	1916.	1917.	1918.	1919.	1920.	1921.
LONDON (average of all stations)—							
Total solids . .	13·93	15·96	14·06	13·36	14·38	10·95	9·09
Tar	0·11	0·14	0·15	0·09	0·12	0·10	0·19
Carbonaceous or sooty matter .	1·96	2·54	2·06	1·69	2·16	1·80	2·26
Sulphates . .	2·93	2·74	2·58	2·50	3·07	1·72	1·05
GLASGOW (Blythswood Square)—							
Total solids . .	..	18·08	13·76	14·63	15·67	11·79	12·42
Tar	..	0·31	0·16	0·17	0·19	0·08	0·19
Carbonaceous or sooty matter .	..	2·42	2·45	2·14	2·82	1·10	2·53
Sulphates . .	..	4·45	2·76	3·43	3·14	2·12	2·02

In Table II. are given the gas-heating appliances which have been installed during the years 1914 to 1920 by the Gas Light and Coke Company. According to the figures supplied by the Company, 235,000 cooking-stoves, gas-fires, water-heaters, and boiler-rings have been sold, or let on hire to the public, during these years; and their records indicate that at Dec. 31, 1920, the number of gas appliances supplied to consumers amounted to 1,430,942, after allowing for replacement and return of stoves. Beyond these figures, a large number of stoves are purchased direct by the public from London stores, ironmongers, &c. Table II. is therefore, owing to the facts above indicated, not a complete record of all the gas appliances in use. Also, this is the record of the Gas Light and Coke Company's figures only, and does not take account of other gas companies. It may, however, be taken, I think, as representing fairly the development of the gas industry; and as such I propose to compare the figures with the atmospheric pollution figures for the same years.

From 1916-1921 there has been a remarkably steady reduction in the amount of deposit, while during the same period there has been a corresponding increase in the number of gas appliances in use. The mean monthly deposit of total solids during the winter of 1916, in London, was 15·96 metric tons per square kilometre, or 41 English tons per square mile. In 1921 the mean monthly deposit of total solids had fallen to 9·09 metric tons per square kilometre, or 23·2 English tons per square mile. Between the years 1916 and 1920 the number of gas appliances in use had increased from 1,312,071 to 1,430,942. Thus there is a correspondence between the figures for gas appliances and for pollution, the latter falling as the former rises. The deposit of sulphates during the same period—1916 to 1920—fell from 2·74 metric tons

TABLE II.—*Gas Light and Coke Company.*

STOVES SOLD.

Year Ended—	1913.	1914.	1915.	1916.	1917.	1918.	1919.	1920.
Cookers	..	3,165	3,305	3,679	5,158	4,352	18,143	30,686
Heaters	..	4,687	4,678	4,754	11,383	6,733	27,825	48,515
Ring-burners	..	5,242	5,873	5,504	5,449	3,674	6,623	7,093
Water-heaters	..	778	815	876	1,168	1,240	1,406	2,082
In use at end of	190,278	13,872	14,671	14,813	23,158	15,999	53,997	88,376
Total sold	..	204,150	218,821	233,634	256,792	272,791	326,788	415,164
ORDINARY STOVES ON HIRE—NET INCREASE.								
Cookers	..	3,806	2,571	3,399	3,696	— 646	— 9,772	— 24,506
Heaters	..	13,463	11,261	16,311	10,266	— 7,308	— 14,780	— 35,160
Water-heaters	..	2,600	2,223	2,467	487	— 1,183	795	679
In use at end of	238,136	19,869	16,055	22,177	14,449	— 9,137	— 23,757	— 58,987
Total on hire	..	258,005	274,060	296,237	310,686	310,549	277,792	218,805
AUTOMATIC STOVES ON HIRE—NET INCREASE.								
Cookers	..	16,502	13,097	13,771	3,719	— 1,919	1,753	1,983
Heaters	..	3,748	3,717	5,078	2,028	— 138	4,018	562
Ring-burners	..	11,233	7,455	4,939	1,004	1,457	1,347	2,061
Water-heaters	..	103	104	92	18	6	180	304
In use at end of	31,586	31,586	24,373	23,880	6,769	— 594	3,688	4,910
Total on hire	..	733,947	758,320	782,200	788,969	788,375	792,063	796,973
Total	..	1,196,102	1,251,201	1,312,071	1,356,447	1,362,715	1,396,643	1,430,942

per square kilometre, or 7 tons per square mile, to 1·72 metric tons per square kilometre, or 4·4 tons per square mile. The deposit of carbon, or sooty matter, was reduced from 2·54 metric tons per square kilometre, or 6·5 English tons per square mile, in 1916, to 1·8 metric tons per square kilometre, or 4·6 English tons per square mile, in 1920. Thus there is a definite correspondence between these particular elements of pollution, which are mainly derived from smoke, and the number of gas appliances installed. This comparison must not be pressed too far, because there are other factors as well as gas which are operating to reduce smoke. During the winter of 1919, the deposit increased, though it was followed by a considerable fall in 1920. This may have been owing to a more general use of inferior coal.

Turning now to a consideration of the data available for Glasgow, in Table III. is given a list showing the number of appli-

TABLE III.—*Corporation of the City of Glasgow—Gas Department. Memorandum Showing the Number of Gas Appliances on Hire, Free Loan, Hire Purchase, &c., for Each Year from May 31, 1914, to May 31, 1921.*

Year ending May 31.	Number of Cookers and Range Fittings on Hire and on Loan.	Number of Grills on Loan.	Number of Gas-Rings on Loan.	Gas Heating Appliances Sold Hire-Purchase System.	Gas Heating Appliances on Hire.	Gas Heating and Cooking Appliances Sold.	Total.
1914	109,338	25,152	37,662	4,119	26,787	4,183	207,241
1915	124,825	25,473	47-358	3,302	45,680	3,111	249,749
1916	134,123	26,373	54,100	2,674	46,612	4,499	268,381
1917	136,319	26,320	58,296	1,060	45,134	6,000	273,129
1918	135,208	26,280	59,007	409	39,494	5,382	265,780
1919	134,363	26,213	59,071	297	36,199	4,952	261,095
1920	135,961	26,159	59,377	93	35,069	8,778	265,437
1921	139,429	25,959	59,831	19	35,392	11,101	271,731

In addition to the above, there are a great number of appliances sold by private plumbers, &c.

ances supplied by the Gas Department of the City of Glasgow between the years 1914 and 1921.

There is in Glasgow, also, an inverse relationship to be observed between the two sets of figures, one giving the amount of impurity deposited and the other the number of gas appliances in use. In the case of Glasgow, the increase in the number of gas appliances in use between 1916 and 1921 amounted to 3350; but this increase was only a little over 1·2 p.ct. of the number in use in 1916. It is to be remembered, however, that the figure given, as in the case of London, cannot be taken as giving the total in use, since a large number of stoves are supplied by plumbers and ironmongers.

As I set out in this paper to bring before you the available facts in this connection, it will be best to allow these facts to speak for themselves; and for this reason I have given the actual figures, both for deposit of atmospheric impurities and for the number of gas appliances in use.

One other point it may be as well to refer to is the unfortunate fact that the prevention of smoke does not result in any immediate economy to the user of the fire. The percentage of fuel lost in smoke is very small at the worst, and the fact that no direct economy results removes this inducement to the user for making any effort to prevent smoke. Arising from this consideration, it seems obvious that the reduction of atmospheric impurities will never be brought about by the initiative of the fuel users, unless where some definite economy can be indicated; and this leads us to the conclusion that it is only by awakening the public to the dangers of continued pollution of the air, so that a general demand will arise for its prevention, that any good is likely to result.

The efforts of the gas companies to extend the use of their products should have every support from those interested in the reduction of smoke, since, in the increasing use of gas, both for domestic and industrial purposes, lies probably our greatest hope for a pure atmosphere in this country, where we have no large waterfalls or high-level lakes which might be harnessed for the production of electricity.

DISCUSSION.

The CHAIRMAN remarked that this subject was a particularly important one from the health point of view. The author had proved to them beyond a doubt that the influence of the use of gaseous fuel was a very beneficial one. Though the figures taken out on a percentage basis were small, he thought it was probable that, if the author had taken the increase in the quantity of gas itself, rather than in the number of appliances, the growth in the use of gas might have been better emphasized. Undoubtedly, during the last six years, over which the author had taken his figures, the quantity of gas used in appliances had increased. People had the appliances before, but did not use them so much.

Bailie SMITH (Glasgow) said he did not know whether those present had noticed, as he had done, the amount of apathy that existed in Great Britain—more especially in the southern part of Great Britain—on this question. Somebody had got to do something. Dr. Owens and the Coal Smoke Abatement Society, one or two people in Manchester, and some of them in Glasgow, had been doing something for several years. It was a splendid movement started in London by the Coal Smoke Abatement Society; but they had not had anything like the support from the public that they ought to have received. Another difficulty was that this question had been criminally ignored by most of the local authorities. There had for many years been powers on the Statute Book to control smoke from manufacturing concerns; but most bodies had never used the powers they possessed. The Government had power to compel local authorities to exercise their functions; but they had never put the power into execution. About June last year, a Departmental Committee (of which he was a member) appointed by the Ministry of Health issued an interim report on the problem of the domestic fire, because of the number of housing schemes being promoted all over the country. A very large number of copies of this interim report were bought by different people; but they found that many local authorities had never heard of such a report, and some who had heard of it did nothing. On Dec. 30 last, the West of Scotland Branch of the Smoke Abatement League called a meeting in Glasgow; and among resolutions passed was one that the Ministry of Health and all local authorities should decline to sanction any housing scheme unless provision was made in the plans for the adoption of smokeless methods of supplying heat. This was sent to the Government; but nothing whatever had been done. Now this was the time, when large numbers of new houses were being put up all over the country, to introduce smokeless methods. They had evidence in connection with this Committee that smokeless methods were rather cheaper in construction, in a new building, than the old-fashioned fireplace. In addition to its being cheaper to instal gas, it was shown that the expense to the occupant of the house during the year, taking all things into account, would probably not be any more. It was shown in evidence that in domestic houses and warehouses, systems of central heating were actually cheaper in construction and cheaper in use, where gas coke could be used as the source of heat. Yet hardly a local body in the country had put any such plans before the authorities for sanction; and the authorities themselves had not taken any action to cause smokeless methods to be installed in the new houses. Thus, their great difficulty had been struggling against this wall of apathy. But, apart from this want of action, smoke abatement from the domestic point of view was bound to come about of itself, because of the labour saving. People insisted nowadays upon having their water through a pipe; and housewives had found it was better to get her fuel in the same way. On its own merits, gas was going to force its way, without any other action. A full report on the manufacturing side would probably be issued in a month or two; and then the whole question could be gone into. But what Dr. Owens had told them, and what they had themselves seen during the coal strike ought to be an incentive to them to push on with the abatement of smoke from a health saving point of view. They knew now that thousands of the citizens of Glasgow and London died annually from diseases of the respiratory system caused by impurity of the atmosphere; so that to Dr. Owens and other authorities who had pointed to the source of the trouble, they owed a great debt of gratitude.

Mr. F. W. GOODENOUGH remarked that, while he was conscious of the apathy in many quarters regarding smoke abatement, to which Bailie Smith had referred, he would like at the same time to point out that, at any rate in the South, there had undoubtedly been an effect upon the housing authorities brought about by the smoke abatement propaganda of the last few years, and by the publication of the interim report of the Departmental Committee on Smoke and other Noxious Vapours. Take the case of the London County Council. They were building at the present time an estate of approximately 3000 houses in the east of London—known as the Becontree Estate. Here they were putting gas-cookers in every house, as well as gas water-heaters, and in every house one, and in many cases two, gas-fires, as part of the first equipment. Therefore there would not be a great emission of smoke from any of these houses. They had not, it was true, gone the "whole hog," but they had gone a good long way; and he could say, in regard to every housing scheme in the district of the Gas Light and Coke Company, that gas-cookers were being installed throughout, and in many cases gas water-heaters and gas-fires. So that one could fairly state that the houses which were being built in London to-day would not contribute as large a cloud of smoke to the city in the future as some of the older ones. He thought this was pretty true of other housing schemes in the country. In Liverpool he knew of one considerable scheme where they had adopted in a number of the rooms a small flue which was only suitable for gas-fires; and they had also installed gas for cooking. In fact, gas for cooking was practically universal in all the housing schemes within his knowledge. Of course, they wanted the local authorities to go still further; but it was only right to say there was distinct evidence that the work of Dr. Owens and others who had laboured in the cause of smoke abatement was having its effect. While one did not want authorities to be unduly proud of what they had done, it would, on the other hand, be a pity if workers were discouraged by a feeling that nothing was being accomplished. The author said that in the increasing use of gas lay most probably the greatest hope for a pure atmosphere. He should have said "and coke," because the largely increased use of gas during recent years had also meant a corresponding, or very nearly corresponding, increase in the output of coke; and the absorption of this coke in place of coal was having its effect on the atmosphere. Coke was being employed in increasing measure for steam-raising purposes and central heating. With regard to Table III., referring to the Glasgow gas appliances, he would suggest an alteration which would make the use of gas appliances more apparent. While in the table the number of gas appliances on loan was a total figure to date, the appliances sold were only the figures for each year. The latter should have been a cumulative figure also, because the apparatus sold in previous years could be assumed to be still in use in 1921. This would give a total figure of about 308,000, instead of 271 000—an increase of (say) 100,000 in the seven years, which was a very striking and also a more accurate figure. There was, perhaps, one reservation which ought to be made in regard to the big drop in impurities in some of the years, so that they should not be discouraged unduly if the drop was not maintained the next year or two. He thought that a certain proportion of the decrease in deposits was due to coal rationing under the Household Fuel and Lighting Order, which made for a decreased use of coal. In the case of something over half-a-million consumers by prepayment meters in North London, during the war period, the average consumption went up 5000 c.ft. per annum—a total of somewhere about 2500 million c.ft. more gas used in existing appliances. This bore

out what the Chairman had said about the importance of taking the increase in the quantity of gas used, rather than in the number of appliances installed. He hoped this higher consumption would be maintained, and the reduction in the pollution of the atmosphere be continued. The increasing use of gas appliances and of coke-boilers for water-heating was bringing about a much greater reduction in the quantity of coal consumed in kitchen ranges than one would at first realize. In many cases, the kitchen range was lighted solely for providing hot water for baths, &c. The author referred to the relative economy of gas and coal; but in making a comparison between the two, one had to take into account the total budget of the household—the possible saving in labour, &c., as well as the actual cost of the fuel.

Mr. W. J. Liberty, referring to the reduction in fogs, said that, as one who was responsible for the supervision of the artificial lighting in the centre of the Metropolis, this was a matter of special interest to him. When they made their last contract with the Gas Company, over ten years ago, the Corporation were very anxious about this daytime lighting-up—because they had to light-up on the least approach of fog. They then managed to squeeze out of the Company 183 hours of free fog lighting. This had never been reached, and each year had receded, until he was now looking forward to the time (and he did not think it would be very long) when the whole of this 183 hours would be wiped right off the slate.

Mr. Thomas Goulden said he would like to touch upon one point connected with the diminution of the pollution of the atmosphere arising from the substitution of gas for coal fires. In the first place, there could be no doubt about the very much more hygienic condition of the atmosphere from this cause. They must not altogether measure the benefits derived by the economy that resulted to the household immediately. Mr. Goodenough had referred to other points besides the mere economy in fuel. One very great thing which always had to be considered—and which certainly was becoming far more widely appreciated through the work of the British Commercial Gas Association, was convenience in the household. They might possibly not save fuel; but look at the enormous saving in labour which resulted. The gain in this way was tremendous. The importance of the avoidance of drudgery to the women of a household was not to be properly judged by a man. Possibly public authorities were not quite up to this matter yet. But a Government as a rule were what the people over whom they ruled made of them; and as education proceeded, there was no doubt public authorities would be stirred-up in this matter. He had been immensely struck by the improved health that accrued from the greater accession of sunlight to the streets of a city, as demonstrated by Dr. Saleeby in his lectures. By burning raw coal, not only did they get deposition of soot and sulphur, which was most objectionable and harmful in every way, but the loss which accompanied it was hardly calculable. When they bore in mind that the coal consumed in domestic use was very much in excess of that employed for the purposes of gas manufacture, it would be understood how far they had to go. He had made a rough calculation before coming to the meeting. In London and the immediate suburbs, they used a certain amount of gas per annum. Now, he took out the quantity of coal that would be used if gas for all other purposes than lighting were done away with; and it meant that they would be using well over 2 million tons of coal a year more than was actually the case; and the whole of the products from this would be passing into the atmosphere. It must be recollected, too, that all the products thus thrown away by the use of raw coal was capable of forming raw material for many industries. In view of this wastefulness of the use of raw coal, local authorities should remember, and consumers also, that they had a duty to the State. It needed to be impressed upon the minds of all consumers of coal, and the public authorities, in this matter of smoke, and incidentally of fuel consumption—a large question—that, by not taking very strong measures with regard to doing away with the use of raw coal, they were depriving the community of a very large quantity of valuable constituents to which he certainly thought that the country had a right. They were under a great obligation to Dr. Owens for the work he had done.

Mrs. Cloudesley Brereton, in proposing a vote of thanks to the author, paid a tribute to the Women's Advisory Committee, presided over by Lady Emmott, who reported to the Ministry of Health. The work of this Committee, and the quiet influence of the women, was having a tremendous effect on local authorities all over the country. It was a dreadful thing that more local authorities had not taken-up the question of labour-saving appliances in new houses.

Dr. Owens briefly replied to the points that had been raised; and the conference then closed.

SILICA BRICK COKE-OVENS.

A paper on the above subject was read by Mr. A. H. Middleton before a meeting of the Coke-Oven Managers' Association, held at the Central School of Science, Stoke-on-Trent, on Thursday Oct. 27—Mr. Ernest M. Myers (President) in the chair.

Mr. Middleton opened by saying that though, up to the present time, there had not been built in Great Britain a single battery of coke-ovens designed to be worked at temperatures necessitating the use of silica brick, and, so far as he knew, only one battery had been built for the walls of which silica brick was employed entirely, he thought the time had arrived when, instead of using quartzite brick as a matter of course, those concerned with the erection of new ovens or the rebuilding of old batteries should consider, on the merits of each case, whether silica brick should not be chosen in preference to quartzite. By "silica brick" he meant one made from quartzite or ganister rock, containing about 97 p.ct. of silica, to which nothing was added with the exception of the necessary fluxing or bonding material; and by "quartzite brick," he meant to imply that composite brick which was almost universally used in this country for the construction of coke-oven walls, and which contained from 77 to 85 p.ct. of silica.

The advantages of using silica brick in place of quartzite for the construction of coke-oven walls might be summarized as follows: (1) Greater output and greater thermal efficiency; (2) greater durability under ordinary conditions; (3) resistance to corrosion where salty coal is used; and (4) the possibility of varying the heat treatment where different classes of coal have to be employed. In considering the first of these points, it might prove interesting to make an examination into the sizes, output, and carbonizing period of several typical American installations, along with the coke and bye-product yields, and compare the results with those obtained by British batteries. This would be to satisfy one that, after making all due allowance for the decreased width of the ovens, a silica construction rendered possible a very much greater output for a coke-oven of given size. This was due chiefly to the higher temperature at which it was possible to work ovens built of silica brick. But the question of the higher conductivity of silica brick at high temperatures must not be disregarded, as there was considerable evidence that this was partly responsible for the improved results obtained.

Ovens of silica construction might be regularly worked, without risk to the walls, at a temperature of from 1300° to 1400° C.—from 200° to 250° higher than it was desirable to go with quartzite brick—and this implied that the brick must not fail at a temperature of from 1500° to 1600° C., seeing that peak temperatures as high as this were liable to occur. While it was doubtful if silica brick was a much better conductor of heat than quartzite brick at temperatures below 1000° C., there was, he thought, very little question that at higher temperatures its conductivity was considerably greater. This appeared to be borne out by results he obtained at one of the American plants which he visited last year, as the increased temperature alone would not account for the greatly reduced coking time.

In studying the effect of higher temperatures upon the yield of bye-products, it seemed worth while to mention that most English coke-oven people were naturally inclined to consider that this greater output of coke from ovens built of silica brick was only obtained at a sacrifice of bye-products; but he was strongly inclined to think this was not the case. It was impossible to make a direct comparison between the yields under English and American conditions, as different classes of coal were used at the different plants; but, generally speaking, the yields of bye-products obtained in America were as high as would be secured in England under English conditions with similar classes of coal. The explanation of these good yields of bye-products, in spite of the high temperatures at which the ovens were worked, was to be attributed to the fact that the American ovens were so constructed that little decomposition took place in the tops of the ovens.

There was not much evidence to support the opinion that silica ovens offered far greater durability under ordinary working conditions, though this was a conclusion at which he had arrived after examining a number of silica walls in America which had been in operation for various periods at high temperatures, and comparing them with what he knew of quartzite walls in this country. The appearance of the American silica bricks which he had brought with him for inspection would, he thought, go far to satisfy his hearers that most favourable results might be expected from ovens built of this class of material, so far as durability was concerned.

At considerable length the author dealt with the resistance of silica bricks to corrosion in cases where salty coal has to be used. The life of the walls, in districts where this salty coal was used, was rarely more than three years, and was sometimes as short as nine months. He believed that all the trouble and expense due to this corrosion would be avoided if the walls were built of silica brick instead of quartzite. At the only plant in Great Britain built of silica brick, two batteries of coke ovens were working side by side with the same coal and under exactly the same conditions, one battery being built of silica brick and the other of quartzite. The silica brick battery had lasted for six years, while the quartzite battery only lasted from three to nine months before the walls had to be rebuilt. No clearer or more convincing evidence could be cited in favour of silica brick. Equally striking results had been obtained in Germany, showing the superiority of silica brick over quartzite where salty coal had to be used.

From the aspect of relative outlay, silica bricks, ton for ton, cost more than quartzite bricks, due chiefly to the extra fuel cost in manufacturing, owing to the much higher temperatures at which the brick must be burnt. This extra cost, however, was almost exactly balanced by the greater output which it was possible to obtain from ovens of this construction. In other words, to carbonize a given amount of coal, the greater number of quartzite ovens necessary would cost the same as the smaller number of silica-brick ovens.

The question of the permanent expansion of silica brick must not be overlooked; for this property was one which was liable to give trouble when silica brick was used for the construction of coke-oven walls—particularly when the ovens were operated at the higher temperatures such as constituted the standard coking practice in America. This should give very little trouble at temperatures at which coke-ovens were usually operated in England; but where it was proposed to work at temperatures 250° to 300° C. higher, very great care must be taken to obtain a brick in which the permanent expansion was low.

In conclusion, the author emphasized the extreme importance of the selection of the best possible raw material for the manu-

facture of silica bricks for coke-oven purposes. The ganister or quartzite rock employed should, generally speaking, contain not less than 97 p.ct. silica, and not more than 3 p.ct. of iron and alumina together. The total alkalies should not exceed from 0·4 to 0·5 p.ct. The best silica brick he had ever seen was made from rock having the following chemical analysis:

	Per Cent.
SiO_2	97·15
Al_2O_3	1·00
Fe_2O_3	1·05
CaO	0·10
MgO	0·25
Alkalies	0·10
	99·65

Raw material, however, could not be selected on chemical analysis alone. Ganister or quartzite rock of identical analysis with the above might be quite unsuitable for making good brick. The physical properties of the rock were equally important. It should be close-grained and hard, or what the quarrymen described as "strong." On crushing it should splinter or break into sharp, angular fragments. Rock that powdered easily, or ground down to round grains without sharp corners, under ordinary conditions would not make strong brick. On heating to high temperatures, the rock should not crumble or show more than the slightest evidence of cracking. Most of the permanent expansion of the rock should take place on the first heating to a high temperature. One that showed little expansion after the first heating, and continued to expand appreciably after each of several heatings, was unsuitable. For the comfort of those who contemplated building coke-ovens with silica bricks, it might be stated that it had recently been established that the specific gravity of the brick bears a very definite relation to the quartz conversion which has taken place in the brick, and to the temperature at which the brick was burnt. If silica brick was intended to be used for ovens which were to be worked at very high temperatures, the use of a brick with a higher specific gravity than 2·35 was not advised.

DISCUSSION.

Mr. T. BIDDULPH-SMITH remarked that we had been told a great many times that America led the way in the carbonizing of dry coal. He would like to know whether the American plants to which reference had been made were actually carbonizing wet or dry coal.

Mr. MIDDLETON said he would imagine that some of the plants were carbonizing wet coal and some dry.

Mr. SMITH (continuing) said that the point was a rather important one, inasmuch as he wanted to give a comparison with some results that were obtained in this country with a quartzite brick plant carbonizing dry coal. While he could agree with the author that silica bricks, where the trouble experienced with salty coals was great, would be the material for the coke-oven of the future, as also might be the case where highly volatile coals were employed which did not give a very good quality coke, he did not share the author's optimism that silica bricks would do everything, or that they were really at the present time a commercial proposition in dealing with average coals which were unaffected by the two difficulties mentioned. In the first place, Mr. Middleton spoke of the relative conductivity of silica bricks and quartzite bricks. He (Mr. Smith) thought the conductivity of silica bricks was much greater than that of quartzite; but he would like to point out that, granting heat was delivered to the surface of the coal in the charge, the rate of the carbonization of the rest of the coal in the charge depended upon the conductivity of the coke made in the interior mass. Therefore he contended that the rate would depend not upon the conductivity of the refractory so much as upon the differential temperature. He had been told by people who had tried silica walls in this country that they could not get the bye-products. One man had told him that he thought this was due to the permeability of the silica brick used to the gases evolved; some amount of gas being lost through the brick itself. Whether the fault was due to this or to the exceedingly high temperature, he could not say. But he believed they were told, when this American practice was first poked at them a couple of years ago, that America was carbonizing dry coal. The reason he had asked whether the coal was dry or wet was that approximately the carbonizing period corresponded with our own,—to the width in inches. With a quartzite brick they were carbonizing a 22 ft. oven in 21 hours. Therefore he must come to the conclusion that the net results of the increased output was due very considerably to dry coal. He also agreed to a large extent with the high temperature; but he thought this was due mainly to the fact that coal was being carbonized with considerably less moisture content than our own. He was of the opinion that all their needs were met by a good quartzite brick, where there was no outside trouble to deal with—such as inferior coal, and so on—and that the extra cost of silica brick production would be quite easily met by tacking on to the battery another oven or two, or by raising the height of the oven.

Mr. E. ESCOT WOOD said it had been his experience that many of the various refractories were easily penetrated by the gases and the carbon deposited, with the result that there was a building-up of carbon on the oven walls. He had noticed this particularly with the English quartzite bricks; but the same trouble had not been noticed with Belgian bricks. The extra cost would not seem to justify them in putting in silica bricks in the place of the ordinary quartzite bricks. They had had excellent experience with Belgian bricks; and with these they had attained to a life of 22 years in one particular lining.

Mr. T. P. CARR said that in Glasgow silica bricks had been in use for six years. When the war broke out, they were building a battery of coke-ovens which were intended to be wholly of quartzite brick; but only sufficient bricks were delivered for the first two courses, so that the contractors had to look round for further supplies. They decided to try silica bricks; for they knew at the time that the particular plant might be troubled very severely with salty coal. A brick was put in from Oughtibridge; and the ovens had been working for six years. The bottom two courses which were built of quartzite had almost completely corroded away—at least half of the brick had disappeared. They had caused so much trouble in the working of the ovens through leakage, causing the ovens to stick, that they had had to cut-out the bottom two courses and replace them with silica bricks; and a whole wall of silica bricks was now in use. A point had been raised in regard to expansion. Possibly the thought would arise that, if ovens had to be frequently relined, trouble might occur; but when using silica bricks they did not anticipate relining in the way that they had been compelled to do with the clay bricks. They had tried a silica sand brick; but this brick did not prove to be in any way superior to the ordinary quartzite brick. As to the Bawtry bricks they had, the moulds were now steel-lined throughout; and the bricks were practically equal to the American bricks which Mr. Middleton had shown them that afternoon. They were very pleased indeed with the bricks which they were now getting from this particular quarter. With regard to cost, he thought he was right in saying that the cost of a silica wall would not be any greater than that of a quartzite wall, for the reason to which Mr. Middleton referred—the difference in the specific gravity of the bricks. They were now getting bricks delivered at a price between £8 to £9 per ton; and he thought the quartzite bricks of to-day were very similar in price.

Dr. J. W. MELLOR agreed that the chances of getting along with a silica brick were greater, not because the silica brick was so much superior to a firebrick, but because the firebrick manufacturers had in the past been exceedingly careless in the making of their bricks. He would question very much whether a first-class firebrick, properly burned and applied, would not be quite as good as a silica brick for the ordinary type of coke-oven. He was certainly not disposed to accept a good many of the reasons advanced why a silica brick should be better than a firebrick. Before he could come to that conclusion, such questions as the influence of a film of carbon and of porosity upon the conductivity would have to be disposed of.

As there were evidences of a desire to continue the discussion, it was suggested that it should be adjourned at this particular stage, and taken up at a later date by the four sections of the Association at the point at which the adjournment was called.

A hearty vote of thanks to Mr. Middleton was passed on the proposition of Mr. J. W. LEE, seconded by Mr. C. B. FINN.

The "Seaboard" Liquid Purification Process.

With the recent installation by the Koppers Company of apparatus for liquid purification of gas at the plant of the Seaboard Bye-Product Coke Company, of Jersey City, the entire gas output is now being treated in this way with, it is said, remarkably successful results. The process is known as the "Seaboard," for the Company have been operating it over a year. During this period, the equipment used had a capacity to purify about half of the gas output; but with the lately-completed apparatus, 25 million c.ft. of gas per 24 hours can be purified. The surplus gas of the coke-oven works is sold to the Public Service Company of New Jersey. From a description appearing in the "Gas-Age Record," it appears that simplicity is one of the main features of the process. It is merely a treatment of the gas with a dilute solution of ordinary soda, which is continuously regenerated by aëration. The unpurified gas passes into a scrubber, which is known as the "absorber." Here it is brought into intimate contact with a solution of sodium carbonate, which is pumped from a tank countercurrent to the gas. The solution contains 3 to 5 p.ct. of sodium carbonate. Ordinary commercial soda ash, which is nearly pure sodium carbonate, is used. The solution absorbs the hydrogen sulphide, together with most of the hydrocyanic acid and some carbon dioxide, from the gas. The fouled solution flows out of the absorber into another tank, and is pumped over a second scrubber, which is known as the "actifier." Air is blown into the bottom of the actifier by a fan, thoroughly aërating the solution. By this means, the absorbed gases are expelled, and the solution regenerated, so that it can be used again to scrub the gas. The regenerated solution runs into the first tank, from which it is continuously pumped back over the absorber. The air and highly diluted gases of decomposition are either passed into a stack to escape into the atmosphere, or may be transferred to the boiler-house or other places where air is required for fuel consumption. The absorber and actifier may be ordinary hurdle scrubbers, such as are commonly used for benzole recovery; but it has been found more satisfactory in new installations to substitute tile packing for hurdles. Very good packing consists of the so-called "spiral ring" tile, well known in chemical works; and these tiles have been used in the new apparatus at the Seaboard plant. On the whole, the results obtained in practical operation of the process have been so successful that it is believed capable of supplanting, to a large extent, ordinary oxide purification.

Sulphate of Ammonia by the Claude Process.—"Engineering" understands that Cumberland Coal, Power, and Chemicals, Ltd., have acquired three collieries in Cumberland with coke-oven plants capable of gasifying 1000 tons of coal per week. These will be used to supply gas to a Claude synthetic ammonia plant to be put down in the neighbourhood. They have also acquired a controlling interest in the Tysse hydro-electric power plant in Norway, which supplies 100,000 electrical horse power to the works of the United Alby Carbide Company at Odda. The Odda works have been taken over; and it is intended to erect there a Claude plant to produce 156,000 metric tons of sulphate of ammonia per annum from electrolytic hydrogen.

REGISTER OF PATENTS.

Atmospheric Gas-Burners.—No. 168,687.

HOWLETT AND CO., LTD., of Birmingham, DOLPHIN, J., of Harborne, and YATES, H. JAMES, of Aston, Birmingham.

No. 15,810; June 11, 1920.

This invention has reference to atmospheric gas-burners, and to nozzles for use with them for heating purposes—more particularly in gas-fires—to prevent flame noises at the nozzle.

Fig.1.

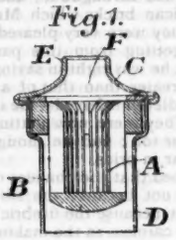
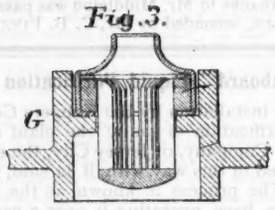


Fig.2.

Fig.3.



Dolphin and Yates' (Howlett and Co.'s) Atmospheric Gas-Burners.

Fig. 1 is a sectional side elevation showing one construction of nozzle or burner. Fig. 2 is a perspective view of the interior refractory member. Fig. 3 is a side elevation showing a modification.

In figs. 1 and 2 the bottom of the tubular refractory part A is made of inverted dome shape; the slits through the wall of the tube being arranged vertically and terminating on a level with the bottom of the interior. The inverted domed end serves to direct the flow of the gas into the annular space B around the tube A, so as to enter the slits at the top of the tube—the slits opening into the countersunk top of the refractory part. The cap C is preferably raised from sheet metal and secured to the cylindrical baffle D, and has an outstanding circular lip with a coned or nozzle shaped top part E with a central upstanding tubular outlet F. The cylindrical part D is preferably made long enough to extend slightly below the inverted domed bottom of the refractory part A. The nozzles made in this way fit in the recesses or holes of the burner casting.

In fig. 3 the cylindrical baffle part G is cast in a piece with the burner casting, and the sheet-metal cap of the nozzle terminates at, or slightly below, the external flange of the refractory part A, to which the cap or nozzle part is secured by being spun over and around it.

Desulphurizing Gases.—No. 170,152.

JOHNSON, J. Y.; a communication from the Badische Anilin-und Soda-Fabrik, of Ludwigshafen-on-Rhine, Germany.

No. 23,031; Aug. 4, 1920.

According to this invention, the gas from which the sulphur compounds are to be removed is first led through a purification vessel in which either it is treated with a suitable washing liquid—such as moderately concentrated sulphuric acid of (say) 82 p.ct. strength—or the vessel may contain a porous mass of active charcoal through which the gas is passed. Certain admixtures of a tarry nature, which would otherwise interfere with the removal of the sulphur compounds, are thereby precipitated or absorbed; while ethylene and sulphur compounds pass on unaltered. After leaving the purification vessel, the gas is passed through a second or reaction vessel, where it is treated in the presence of oxygen (preferably of air) with active charcoal. The oxygen may be added by introducing at least the amount required for the oxidation of the sulphuretted hydrogen either before or (more suitably) after treatment in the purification vessel. A reaction takes place between the sulphuretted hydrogen and the oxygen, with the well-known result that sulphur is formed and deposited on to the charcoal. When the latter no longer absorbs sulphur, the sulphur is extracted by means of a suitable solvent, or the charcoal is otherwise deprived of the sulphur and can then be used again.

In case the purification of the gas is effected with the aid of an acid, a small amount of ammonia or ammonium carbonate may be added to the gas entering the reaction vessel or to the catalytic mass contained in it.

According to the efficiency of the purifying treatment and to the size of the several vessels, one purification vessel may be combined with one or several reaction vessels, or a number of purification vessels may be provided for each reaction vessel. As the porous mass contained in the vessel becomes inefficient in course of use, it can be revived by treating with suitable solvents or with steam.

Fuel for Gas-Fires.—No. 170,372.

DOWLER, W., of Walthamstow, and GUINNESS, A. T., of Southend-on-Sea.

No. 21,500; July 16, 1920.

This fuel for gas-fires, when placed in contact with a flame, is said to incandesce like asbestos fireclay and has "a greater calorific value even than coal." The composition is characterized by a hardness of textile and the fact that it "closely resembles coal" in its appearance.

For preparing the composition the following materials are used: Blue clay, wood chips, coal dust, green copperas, extract of logwood, rock ammonia, and alum. These substances are first mixed so as to obtain a pulp, and after soaking for some time in water, and grinding, the composition is formed into bodies of any desired shape. They are then placed in a furnace with a layer of coke between them and consolidated into a mass of the requisite properties. This, when withdrawn, has a dull black appearance, due assumedly to the contact with air.

According to one form of the invention, the substances forming the composition are mixed in the proportion of blue clay six parts, coal dust two parts, wood chips one part, extract of logwood half a part, and green copperas, rock ammonia, and alum a quarter part.

Gas-Burners.—No. 170,376.

PARKINSON STOVE COMPANY, LTD., GIBB, D. MACC., and HICKINBOTTOM, F., of Stechford, Birmingham.

No. 21,521; July 17, 1920. No. 8879; March 23, 1921.

This combined invention relates to burners for gas-fires, of the type wherein the mixing chamber is provided with one or more nozzles or jets each having a cavity or housing beneath it within which a conical or dome-like baffle or breaking-up member is located.

Fig.1.

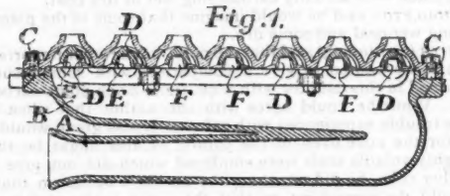


Fig.2.

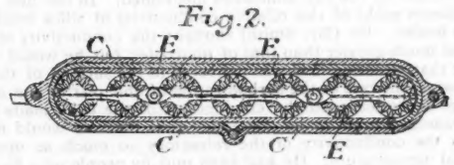


Fig.3.

Gibb and Hickinbottom (Parkinson Stove Company) Gas-Burners.

Fig. 1 represents a vertical section through the burner. Fig. 2 is a horizontal section showing the underside of the baffle or breaking-up members in the upper portion of the burner—the bar by which the baffle members are supported being shown in elevation. Fig. 3 is a vertical longitudinal section through the upper portion of the burner with the baffle members removed—the baffle supporting bar and one of the baffle members being shown separately.

As shown, the burner comprises an inlet tube A, which leads into one end of the bottom of a trough-shaped mixing-chamber B, provided with a detachable cover C secured upon a seating round the upper edge of the burner body by bolts and formed with a series of integral hollow dome-shaped bosses or raised parts which terminate in central nozzles or jets. Housed within each of the cavities is a dome-shaped baffle or deflector D, which serves to split-up the air and gas and ensure more efficient mixture. Each of the baffles is formed upon its underside with a central recess E, while they are formed upon their outer face with ribs or flanges extending from the edge of the recess upon the underside of the baffle—alternate ribs extending to the top of the latter and fitting closely the cavity of the housing, while the intermediate ribs are smaller and terminate a short distance from the top of the baffle, as shown. The ribs thus cause a splitting-up of the mixture, which is free to pass between them to the jet. The recess upon the underside of each of the baffles is arranged to fit loosely upon a conical seating or support F carried by a longitudinally

disposed bar secured by bolts to the upper detachable half of the mixing chamber.

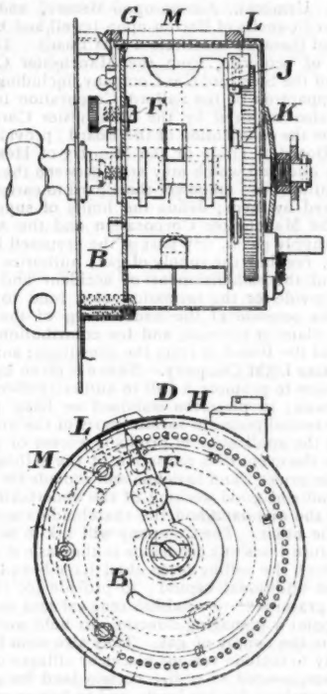
In operation, the mixture of gas and air passes into the mixing-chamber, when it is caused to pass between the baffles D and the inner walls of the dome-shaped raised parts before it can gain access to the burner-jets. The gas and air are thus split-up by the ribs and a more perfect mixture is said to be secured; while a "noiseless flame of higher temperature is obtained having greater stability."

Prepayment Meter Mechanism.—No. 170,603.

ANDERSON, J., of Edinburgh.

No. 8223; April 19, 1920.

This price-changing mechanism is particularly (although not exclusively) applicable to gas-meters, with respect to which it is more particularly described. The object is to provide an improved price-changing mechanism of the disc change type.



Anderson's Prepayment Meter Mechanism.

In carrying the invention into effect in the form illustrated, the price-changing device comprises a disc with a curved slot B near the centre and extending through about 240°, and a series of perforations, say 45 in number, near the periphery. They are numbered in units according to the price of gas; and, in addition, a series of notches D on the edge of the disc correspond to the series of perforations. On the face of the disc there is mounted an arm pivoted in the centre of the disc, and carrying a stop F into a knob Z extending through the curved slot and a pin G adapted to take into the perforations. Behind the disc a coin-pocket H rotates—mounted loosely on a central shaft and turned by a handle engaging the end, so positioned that the edge of the coin carried in the pocket can engage the stop F at the part of its travel determined by the position of the stop—that is to say, by the price of the gas. The coin is initially held in the pocket; its lower edge resting when first inserted on a spring-controlled link or stirrup formed with a right-angled bend X at its end for that purpose. Behind the coin-pocket is a plain disc J—the clearance being only sufficient for efficient operation, so that the penny will not fall away from, or out of, the path of the connecting stop; and behind this disc a large ratchet wheel K is mounted. For the purpose of operating the ratchet, a pawl L is provided carried on a rod M, which also carries the link referred to above. This pawl is controlled by a light spring keeping it in engagement with the ratchet wheel. The pawl is mounted at the back of the disc J on the same rod as the link initially holding the penny; the rod M, with others, supporting and connecting the price-changing disc.

In operation, the price-changing arm, having been set to the position corresponding to the price of the commodity to be supplied, and locked in position by the screwed knob, a coin is inserted into the pocket H and falls on to the pawl or link below. On the operating handle being slightly rotated, the coin in the pocket is carried off the lower part of the link, and if the handle be rotated in a backward direction for the purpose of bringing the coin again below the coin slot to extract the coin, this will be found impracticable, because its engagement with the face of the bottom part of the link prevents it coming below the slot. On further rotation of the operating handle in the proper direction, the coin contacts with the stop F, and the ratchet quantity wheel K is rotated—being driven by the pawl L carried by the rod connecting the discs A and J, which are themselves driven by the coin engaging the stop F. When the coin-holder reaches a position approximately vertically downwards, the edge of it comes into contact with a fixed stop (not shown), whereby further forward rotation is prevented, and the coin falls from the coin-holder on releasing the forward pressure on the handle. On rotating the handle in the backward direction, the discs A and F are returned to their initial position by the coin-pocket engaging the rod M after an interval of free movement.

Manufacture of Ammonium Sulphate.—No. 170,613.

SOUTH METROPOLITAN GAS COMPANY, and PARRISH, P., of BLACKHEATH, S.E.

No. 12,039; April 30, 1920.

When it is required to make neutral ammonium sulphate by neutralizing the crystals removed from the saturator, it is (the patentee points out) desirable that the liquor in the saturator should be maintained at a low degree of acidity. On the other hand, in certain cases—more particularly in coke-oven bye-products recovery plants—it is desirable to maintain this acidity at a considerably higher degree than that referred to above, in order to avoid the production of compounds from the cyanogen compounds in the gases entering the saturator, and consequent discoloration of the ammonium sulphate. By the present invention it is said to become possible to work the saturator at the low degree of acidity desirable for making neutral sulphate, without fear of discoloration of the sulphate.

For this purpose the cyanogen compounds are prevented from passing into the saturator by fixing them by taking advantage of the well-known reaction, frequently applied for removal of hydrocyanic acid from coal gas, between a polysulphide and a cyanide to form a sulphocyanide. With this object, a polysulphide is added to, or produced in, the ammoniacal liquor before it is distilled, or the gases from the still are washed by a polysulphide.

For instance, when the saturator is used in conjunction with an ammonia still, ammonium polysulphide may be introduced into the liquid destined for the still, in quantity sufficient to convert into sulphocyanide the cyanide present in the liquor.

There are other methods which are equivalent to the addition of polysulphide—for instance, the addition of finely subdivided sulphur or the passage of the vapours leaving the still or plant through spent oxide contained in suitable vessels capable of alternate operation, or the formation of polysulphide in the liquor by blowing air or other gas containing oxygen or its equivalent through the liquor, before the latter is introduced into the still.

Manufacture of Incandescent Gas-Mantles. No. 170,679.

SOPER, J. P. H., and TERRELL, T., of Leyton.

No. 22,427; July 28, 1920.

This invention is particularly applicable to the manufacture of mantles known in the trade as "soft"—that is, mantles sold in the unincinerated condition. It may, however, also be used in the manufacture of hard mantles.

The patentees claim to have found that if, instead of converting the nitrates of thorium and serium into oxides, they are converted into fluorides, or fluorides admixed with oxides, the mantles produced have less tendency to shrink while burning-off than the simple oxide-impregnated mantles. Moreover, the mantles containing the fluorides are "more efficient in that they give a greater emission of light for the same gas consumption than do the mantles containing the oxide."

The best method for carrying the present invention into practice is as follows: The knitted fabric of a mantle is made from artificial silk (hydrocellulose); and it is first soured in dilute acid, thoroughly washed, and dried. It is then dipped into a solution of the nitrates of thorium and cerium prepared in the usual manner and dried—preferably in a warm air at a temperature of (say) 90° Fahr. A 10 p.ct. solution of commercially pure and neutral sodium fluoride is prepared, and a small quantity of ammonia is added to the solution to make it slightly alkaline—a proportion which has been used being 2 parts in 1000. Into the solution thus rendered alkaline the dried impregnated fabric is dipped. The action of the sodium fluoride is to precipitate the fluorides of thorium and cerium into the artificial silk; and there is also present a small percentage of oxides of thorium and cerium. The fabric is then thoroughly washed to remove substantially all the soda which may be present as soluble salts, and is dried, preferably in a current of warm air, and made up into mantles in the ordinary way. The mantles produced in this manner may be sold as soft mantles, or they may be burned-off in the factory and sold as the ordinary hard mantles.

Incandescent gas-mantles manufactured in the manner described have the advantage that the shrinkage and deformation ordinarily obtained in the process of burning-off is substantially absent. This is of particular advantage in the case of soft mantles which are burned-off by the consumer on the burner on which the mantle is to be used, since it is not necessary to effect the burning-off in two stages, as is supposed to be done. An ordinary soft mantle should be ignited and burned-off completely before the gas is turned on. If the user does not follow out this process, the mantle will probably be distorted and liable to break; whereas with mantles manufactured according to the present invention, "since there is little or no shrinkage or distortion, the burning-off operation may be effected in a single stage without causing deterioration of the mantle."

Imperial Continental Gas Association's Claim.—"The Times" is informed by the Imperial Continental Gas Association that the £1,600,000 which is payable to them under the agreement made with the German Government will not be received for a few months. The money is not in respect of the proceeds of liquidation of the Association's property in Germany, but is payable under Article 297; and as such the agreement must come before the Mixed Arbitral Tribunal for confirmation. Stockholders in the Association need not anticipate any distribution for some time to come.

PARLIAMENTARY INTELLIGENCE.

NOTICES GIVEN FOR BILLS (SESSION 1922) RELATING TO GAS SUPPLY.

Notices have so far been published of the following Bills which it is intended to promote, in connection with gas undertakings, in the 1922 session of Parliament.

Birmingham Corporation.—Among other powers sought by the Birmingham Corporation are included regulations regarding the sale of coke. The suggested provisions are to require the delivery of a weight ticket or note on sale and the affixing of metal labels to sacks indicating the weight of coke therein; and to enable the purchasers and the officers of the Corporation to require coke to be weighed, and to require the vendors of coke to paint their names and addresses on their vehicles. They also desire to make further provision in regard to financial matters and rating, including the application of the revenues of the several undertakings of the Corporation.

Blackburn Corporation.—In a General Bill, the Blackburn Corporation will seek power to extend the borough to include portions of the townships of Rishton, Ramsgreave, and Livesey; to regulate the supply of gas; to borrow money for the provision of working capital for the gas undertaking; to provide for the consolidation of all the loans of the Corporation from time to time outstanding, and for the application of the revenues of the gas and other undertakings; and to enable them to grant gratuities to officers and servants in cases not within the Workmen's Compensation Act.

Bolton Corporation.—An Omnibus Bill of the Bolton Corporation will include provisions for the establishment of a superannuation fund for officers and servants, and for their compulsory retirement; for the redemption of gas annuities; for the borrowing of money for the provision of working capital in connection with any undertaking; for enabling them to use money standing to the credit of sinking funds instead of borrowing; and for fitting-up show-rooms and offices, and giving exhibitions and demonstrations of the use of gas or electricity.

Doncaster Corporation.—An Omnibus Bill to be promoted by the Corporation contains a clause to enable them to require the payment by occupiers of the expenses of re-connecting a supply of water, gas, or electricity after disconnection owing to default on the part of any such occupier; to authorize the Corporation to use any sinking fund instead of borrowing; and to make provision as to the application of the revenue of the gas and other undertakings of the Corporation, and as to the formation out of such revenues of reserve funds and funds for working capital, and as to meeting any deficiency in the annual income of the undertakings.

Neath Corporation.—The objects of a Bill to be promoted by the Neath Corporation include the extension of the borough boundaries so as to include parts of the urban district of Briton Ferry and of the borough of Port Talbot, and certain parishes; the extension, to include the added areas, of the Corporation's limits for the supply of gas; and the compensating of officers of any authority in the added area who may suffer any loss by abolition of office or diminution or loss of fees or salary. The Corporation also ask for further power in regard to their gas undertaking, including the purchase or supply of gas in bulk. A further clause is to "empower the Corporation to make, produce, or buy gas not complying with the requirements as to illuminating or calorific power, purity, or pressure prescribed by their Acts, and to supply such gas by agreement to any authority, company, or person within their limits for the supply of gas for any purpose other than lighting; to exclude from application to any such gas the provisions contained in the Gas-Works Clauses Acts, 1847 and 1871, and the Acts relating to the Corporation's gas undertaking; and to prescribe such limitations and conditions in relation to such gas as may be deemed necessary or expedient." They desire power to attach brackets, wires, lamps, apparatus, and other works and conveniences to buildings for lighting streets, and to prescribe the terms and conditions upon, and subject to, which the same may be attached.

Ramsgate Corporation.—One of the clauses in an Omnibus Bill to be promoted by the Ramsgate Corporation is to make further provision with regard to their gas undertaking, and in particular to authorize them to make a minimum charge in cases where a supply of gas is taken as a stand-by only; to charge for reading meter indices and rendering accounts for periods less than a quarter, and at times other than the usual times for rendering the quarterly accounts; to provide for the period of error to be assumed in the case of defective meters; and to authorize the Corporation to apply a portion of the profits from the gas undertaking in any year to the accumulation of a sum to be used for the purpose of working capital. There is also provision for the establishment of a superannuation fund for Corporation officers and servants; for the borrowing of money for working capital for the gas undertaking; and for the formation, maintenance, and application of sinking funds, the use of sinking funds instead of borrowing, and the use of sinking and reserve funds for temporary revenue purposes.

Sheffield Gas Company.—The Company intend to apply for an Act to substitute basic prices and basic rates of dividend for the existing maximum or other prices and maximum or other rates of dividend stated in the Acts and Orders relating to the Company; to empower the Company to increase the prices and to charge differential rates; to make provision as to the allocation and distribution of profits, &c., among stockholders, staff, and employees; to empower the Company to pay pensions or superannuation allowances to employees or their dependants; to establish schemes for securing the participation in the profits of the Company of the employees; and to increase the borrowing powers of the Company.

Stoke-on-Trent Gas Consolidation.—The Corporation of Stoke-on-Trent give notice of their intention to apply for leave to bring in a Bill to empower them to purchase the Staffordshire Potteries station of the British Gas Light Company, Ltd.; to provide for the maintenance and carrying on of the undertaking until the transfer to the Corporation of all or any of the officers and servants of the Company employed in the undertaking; and to provide for the payment of compensation to such of the officers and servants in the regular employment of the Company (if any) as may lose their offices or employment by reason of the transfer. They will also ask to have applied to the undertaking, and the area of supply of the Company in connection therewith, all or any of the provisions of the enactments relating to the supply of gas of, or in relation to, the Corporation, or any of their existing gas undertakings. The Bill will provide for the cesser of the rights of the Stone Gas Light and Coke Company, Ltd., in relation to the supply of gas in so much of the parish of Stone Rural as does not lie within 3 miles of the Town Hall of Stone; for the sale of any portion of the undertakings which may be situated outside the parish of Stoke-on-Trent; for regulating the price, quality, and supply of gas; and for the borrowing of money.

Stretford and District Gas Board.—Notice is given that application is intended to be made to Parliament by the Urban District Councils of Stretford, Urmiston, Ashton-upon-Mersey, and Sale, and the Rural District Councils of Barton-upon-Irwell and Bucklow, or any two or more of them, to constitute a Gas Board. This Board is for the purpose of acquiring from the Manchester Corporation the undertaking of the Stretford Gas Company, including the gas mains, pipes, and apparatus of the Salford Corporation in the parish of Davyhulme, also acquired by the Manchester Corporation. The Bill will define the constitution of the Board; provide for the settlement by the Board of Trade or the Ministry of Health or by arbitration of any question which may arise between the Board and the constituent authorities; empower the Board to carry on the undertaking acquired by them; define the limits of supply; repeal the powers of the Manchester Corporation and the Altrincham Gas Company to supply gas in any part of the proposed limits of supply of the Board; regulate the supply of gas; authorize the borrowing of money, and the establishment of accident and fire insurance funds; and provide for the formation of a fund for meeting deficiencies in the revenue of the undertaking of the Board or any extraordinary claim or demand, and for contributions thereto from the revenues of the Board or from the constituent authorities.

Windsor Royal Gas-Light Company.—Notice is given by the Company of their intention to promote a Bill to authorize them to sell gas on a heat-unit basis; to prescribe standard or basic prices for gas, including differential prices in various parts of the limits of supply; to provide for the application of profits in excess of the basic rates of dividend in the event of a reduction of the selling prices of gas below the basic prices; and to define and provide for the appropriation of the results of good working of the undertaking between the consumers on the one hand and the shareholders and employee co-partners on the other. The Company will ask to be authorized to make-up in future years any deficiency in the basic dividends paid in any year in which the selling price shall have been below the basic price; to raise additional capital; to provide for the payment of pensions and gratuities; to establish renewal and special purposes funds; to appoint a managing-director; to hold annual meetings; and to regulate the supply of gas. They also wish to extend their limits of supply to include various places or villages in the parish of Bray; to be empowered to utilize certain land for gas-works purposes, and to purchase further land; and to buy or sell gas in bulk.

LEGAL INTELLIGENCE.

EMBEZZLEMENT CHARGE AT YEOVIL.

George Fenwick, formerly Manager of the Yeovil Gas-Works, has been committed for trial at the Quarter Sessions, charged with embezzling £416 8s. 4d. and £156, the money of the Corporation.

Mr. J. A. MAYO (for the prosecution) said one of Fenwick's duties as gas manager was to estimate the amount of money required for wages, and draw cheques as he required them. These wages amounted to from £500 to £800 a month. In the course of time, the amount accused drew far exceeded the sum he paid in wages; and this difference was the money the prosecution said he had appropriated. In 1920, there was a deficit on the wages account of £26 14s. 1d., which had grown in August to a sum of £108 9s. 9d., and in March, 1921, to £470 4s. 5d. From this had to be deducted payments for petty cash, about £62. The Borough Treasurer was taking over the gas-works finances on March 31; and Fenwick, by his direction, had a requisition for wages for the ensuing fortnight, being instructed to draw two cheques for £150 each. The assistant manager reminded him that there was a large sum shown in the books as available for wages; and accused said that, under the Borough Treasurer's instructions, he was paying over the balance to him. On the following day accused disappeared; and when the safe of the works was forced open, it was found to contain 2s. 2½d.

Major *Batten*, Town Clerk, said that prisoner was then in receipt of a salary of £350 a year.

Mr. F. S. BOXALL (for Fenwick) admitted all the cheques and the sums in default, and applied for a remand with a view of making good part or whole of the deficiency.

Mr. MAYO said, in regard to the second charge of embezzling £150, that the money collected from coin meters was put into a separate safe. Fenwick had borrowed varying sums from the collector, giving I.O.U.'s. Many of these had been redeemed; but when he disappeared, £156 was outstanding.

Prisoner had nothing to say.

The Bench refused the application for a remand, but allowed bail, prisoner in £100 and two sureties of £350 each.

MISCELLANEOUS NEWS.

GAS REGULATION ACT APPLICATIONS.

The following further notices have appeared in the "London Gazette" of applications by gas undertakings to the Board of Trade under section 1 of the Gas Regulation Act.

Ripley Gas Company, Limited.

The standard price now authorized in respect of the supply of gas by the undertakers is 3s. 8d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 5d. per therm.

Warminster Gas and Coke Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 6d. per therm.

Wimborne Minster Gas and Coal Company, Ltd.

The standard price now authorized in respect of the supply of gas by the undertakers is 4s. 1d. per 1000 c.ft.; and the price they have asked the Board of Trade to substitute for this is 1s. 4d. per therm.

SPECIAL ORDERS.

East Kent Gas.

Application has been made under section 10 of the Act by Messrs. Drew-Bear, Perks, and Co., Ltd., of No. 110, Cannon Street, E.C., for a Special Order granting powers to be vested in a company to be registered to erect works and manufacture and supply gas in scheduled portions of the rural districts of Eastry, Dover, Elham, East Ashford, Bridge, Blean, and the Isle of Thanet.

Elstree and Boreham Wood Gas Company, Ltd.

The Company have applied for a Special Order to authorize them to erect works, to increase the borrowing powers, and to make provisions with regard to the price and supply of gas.

Swansea Gas Light Company.

The Company intend to apply for a Special Order to empower the Directors to appropriate out of revenue as part of the expenditure on revenue account such sum as may be prescribed in the Order to a sinking fund to be formed under the provisions of the Order for the redemption of any capital representing the estimated increased cost consequent upon the war of the construction of the works now in progress at Morriston and authorized by the Swansea Gas Order, 1914. They also ask for power to issue redeemable or irredeemable preference or debenture stock, and to regulate the supply of gas.

DECLARATIONS OF CALORIFIC POWER.

Burnham Gas Company, Ltd.—450 B.Th.U. (Dec. 31.)
Grays and Tilbury Gas Company.—400 B.Th.U. (Dec. 20.)
Rushden and Higham Ferrers District Gas Company.—460 B.Th.U. (Nov. 30.)
South Shields Gas Company.—475 B.Th.U. (Dec. 1.)

GAS REGULATION ACT ORDERS.

The Director of Gas Administration has forwarded copies of the following further Orders made by the Board of Trade under section 1 of the Gas Regulation Act.

Chertsey Gas Consumers' Company, Ltd.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 17·8d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-three-quarters. (Nov. 18.)

Hampton Court Gas Company.

After the declared date (1) The standard price in respect of gas supplied by the undertakers shall be 17d. per therm; (2) the price of 16·6d. per therm shall be substituted for the price of 3s. 4d. per 1000 c.ft. mentioned in the proviso to section 32 (dividend dependent on price) of the Hampton Court Gas Act, 1903.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the half year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-one-half.

The minimum permissible pressure at which gas shall be supplied by the undertakers shall be such as in any main, or in any pipe laid between the main and the meter having an internal diameter of 2 in. and upwards, to balance a column of water not less than 2 in. in height. Provided that: (1) The foregoing provision shall not apply to the area of supply of the undertakers situated beyond a radius of half-a-mile from the works of the undertakers, until Jan. 1, 1924; and during the period between the date of the Order and the said date the pressure at which gas shall be supplied by the undertakers within the above area shall be such as in any main or pipe laid between the main and the meter having an internal diameter of 2 in. and upwards, to balance a column of water not less than 12-10ths in. in height; and (2) if the declared calorific value is less than 350 B.Th.U., the minimum permissible pressure at which gas may be supplied shall be that specified in the schedule (below) to this Order.

Where the declared calorific value is below 350 B.Th.U. and not below 300 B.Th.U., the minimum permissible pressure shall be 2¼ in. Where the declared calorific value is below 300 B.Th.U., the minimum permissible pressure shall be such pressure (not being less than 3 in.) as shall be prescribed by the Gas Referees. (Nov. 23.)

Heathfield and Waldron Gas Light and Coke Company, Ltd.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 19d. per therm; and this price shall be substituted for the price of 5s. 6d. per 1000 c.ft. wherever it occurs in section 24 (price of gas) of the Heathfield and Waldron Gas Order, 1915. Prepayment meter clauses are included. (Nov. 21.)

Raunds Gas Light and Coke Company, Ltd.

As from the declared date, the maximum price in respect of gas supplied by the undertakers shall be 17d. per therm; and this price shall be substituted for the price of 4s. 9d. per 1000 c.ft. wherever it occurs in section 24 (price of gas) of the Raunds Gas Order, 1906. (Nov. 21.)

Rushden and Higham Ferrers District Gas Company.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 13·4d. and 14 6d. per therm; and these prices respectively shall be substituted for the prices of 3s. 6d. and 4s. per 1000 c.ft. wherever they occur in section 61 (dividend dependent on price charged) of the Rushden and Higham Ferrers District Gas Act, 1899.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by five.

After the declared date, 0·4d. per therm shall be substituted for 2d. per 1000 c.ft. in section 62 (discounts) of the Rushden and Higham Ferrers District Gas Act, 1899. (Nov. 17.)

St. Neots Gas and Coke Company.

After the declared date, the standard price in respect of gas supplied by the undertakers shall be 18·2d. per therm.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by five-and-one-fifth. (Nov. 21)

York Gas Company.

After the declared date (1) The standard price in respect of gas supplied by the undertakers shall be 13d. per therm; (2) 1·2d. per therm shall be substituted for 6d. per 1000 c.ft. in sub-section 2 of section 47 (dividend dependent on price charged) of the York Gas (Consolidation) Act, 1912.

For the purpose of ascertaining the authorized rate of dividend for the year in which the declared date occurs, the price charged per 1000 c.ft. during that part of the year (if any) before the declared date shall be rendered into the equivalent price per therm by dividing it by four-and-fourth-fifths. (Nov. 22.)

GAS PURCHASE SCHEME IN THE POTTERIES.

Something of a revolution in the gas supply of the Potteries will, says the "Birmingham Post," be effected when the Stoke-on-Trent Corporation's ambitious new scheme is put into operation.

The Corporation have agreed upon a bold policy in purchasing from the British Gas Light Company their works at Etruria, at a cost of £345,000, *plus* £40,000 mortgage debentures, which, together with £15,000 for transference costs and compensation to officials, will make a total of £400,000. At present the Corporation own four gas undertakings in the Potteries, situated at Burslem, Stoke, Fenton, and Longton; and the British Gas Light Company have works at Etruria and Tunstall. The present scheme, which is awaiting parliamentary sanction, has been embarked upon by reason of the fact that the Corporation were faced with an expenditure on all their works amounting to a total of £285,000 during the next ten years. Even this large amount in repair and renewal of plant, however, would not result in permanent efficiency.

The new scheme provides for the centralization of the manufacture of gas for the whole of the Potteries area. The Gas Engineer (Mr. A. Mackay) contends that there is overlapping and inefficiency in the present system of four undertakings. Etruria is to be made the central works for the Potteries and the surrounding districts where the Corporation have power to supply; and new plant will be erected there for the manufacture of gas. The plant will be capable of making between 4 and 5 million c.ft. of gas per day, equal to the combined manufacture of the Burslem, Stoke, Fenton, and Longton works. The coal bill will be considerably reduced. The gas manufactured at the central works will be distributed under high pressure to the holders at each of the existing works. A tar distillation plant will be erected at the central works.

The financial arrangement between the Corporation and the British Gas Light Company is that £100,000 shall be paid in cash, and the remainder taken up in Corporation bonds. The new capital which will be created when the whole of the work is completed will be approximately £1,000,000, taking into consideration what the Corporation will receive for plant that will be discarded at the existing works. Mr. Mackay fully believes the scheme will result ultimately in a reduction in the price of gas averaging from 9d. to 1s. per 1000 c.ft. The Corporation will probably take over the works in the spring of next year; and the whole scheme is expected to be completed in five years.

Cheaper Gas at Newcastle.—The Directors of the Newcastle and Gateshead Gas Company announce a reduction in the price of gas, as from the December readings of the ordinary meters, of 1d. per therm, equivalent to 4⅜d. per 1000 c.ft. The reduction will be made to prepayment consumers by way of rebate.

BRITISH SULPHATE OF AMMONIA FEDERATION, LIMITED.

Increase in Membership—The Nitrogen Problem.

The First Annual General Meeting of the British Sulphate of Ammonia Federation, Ltd., was held on the 17th inst., at the head office of the Company, No. 30, Grosvenor Gardens, S.W.—Mr. D. MILNE WATSON, the Chairman of the Company, presiding.

The SECRETARY read the notice convening the meeting and the report of the Auditors.

The CHAIRMAN said: Gentlemen, I think this Company is probably unique, taking into account both the number of its adherents and the variety and diversity of interests which they represent. We have nearly 400 manufacturing members and associates by agreement. They include builders of battleships and urban district councils; some of the largest coalowners, and many of the largest coal consumers; oil producers and oil users; gas and electricity; many of the largest private firms; and many of the oldest and greatest of public corporations in the country. The Federation represents an idea—the idea of co-operation among producers to secure the highest standard of production and the widest possible distribution of their product. It is our business to watch the constitution of your Company to see whether it is capable of working-out that idea in practice. For I think we all admit that the idea underlying the Federation is perfectly sound from an economic point of view. It may have come as a surprise to you that a report so optimistic in tone has been issued at a time when grave problems, political, economical, and social, confront us and render the future dark and uncertain. I wish to make it clear that our optimism is bred not of any exaggerated sense of the importance of our personal efforts, but solely of a very real satisfaction at the way in which the Federation has emerged from an ordeal formidable enough to shake the foundations of much older and bigger institutions.

VALUE OF CO-OPERATION.

I feel that our position is rather like that of those old dyke-builders in Holland, who prepared for the onslaught of an inexorable enemy by setting all their countrymen to build up a solid rampart, and then had the satisfaction of seeing their handiwork resist the tempest. The Federation has been able to resist the waves of American, Chilian, and German competition; and, by maintaining an unbroken front, to preserve the interests—I think I may almost say the existence—of British sulphate of ammonia makers. For once we are able to say "Just in time," instead of "Too late." We are in the happy position of being able to say this simply and solely because the idea underlying the Federation was sound. I know that those present here to-day, and the many hundreds of other keen business men who are interested directly and indirectly in the Federation, must from time to time ask themselves the question: "Have we done right by our own companies or corporations in joining this Federation?" I have had to ask myself this question as Chairman of my own Company. I can say with a clear conscience on my own behalf, and on behalf of my colleagues on your Committee, who represent a very considerable proportion of the total British output of sulphate of ammonia, that we are convinced that in joining the Federation we have acted in the best interests of our own companies or corporations as sulphate of ammonia producers. We believe that it is immeasurably better, from the point of view of each individual maker, that he should be a member of a Federation which can exercise a very real influence in determining the general level of price, rather than that he should seek, by competing with his fellow producers, to obtain some trifling individual advantage which must necessarily be gained at the expense of the general level of price. The producer wants a steady remunerative price for his output; not violent fluctuations in price, which unsettle the consumer and are the ultimate cause of social discontent and upheaval.

INCREASE IN MEMBERSHIP.

A steady price can only be maintained if the producer has an effective voice in controlling sales and the destination of his product. And when you have a large aggregate production made up of a great number of small producing units, the only way in which they can gain that effective voice is by combining together and centralizing their marketing operation. When they have combined, they are benefiting not only themselves but all other producers of their commodity. I say this advisedly, because, as you know, there are still a few British makers who are not members of the Federation. You will have read with satisfaction in the report that we have been able to increase our membership during the past year, and that the Federation now represents well over 90 p.ct. of the total British output. To the few makers who still remain outside, I would say that, whether they like to admit it or not, they are benefiting by the existence of the Federation. We have appealed to them to join us, and we shall continue to ask them to do so, not for the sake of the few extra pounds a year which their adherence would enable us to spend on our propaganda work, but because we think that, in the difficult times ahead of us, the fewer the divisions among us at home the better our chances of meeting competition from without and revolutionary proposals as to the organization of industry from within.

MANUFACTURERS AND POLITICS.

The point about the foreign competition is obvious. But I would like to dwell for a moment on the other danger, because that is not receiving the attention which it merits. We are living in an age of unstable Government and violent social and political experiment. Far be it from me to suggest that we should take an alarmist view about affairs in this country. I am a profound believer in the solid common sense of the British people. Nevertheless, it is possible that, as a result of political and economic conflict and the rather regrettable aloofness which business men as a whole display towards the problems of Government, you may have some day political forces in power in this country whose object will be to "socialize" the means of production and distribution. The Socialist appetite has been whetted by the vast schemes of control put into force during the war. To my mind, the only way to prevent experiments of this kind, which may be disastrous to us all, is for manufacturers throughout the range of industry to combine together in order to improve their methods of production, to study the needs of the consumer at home and abroad, and to widen their markets. The best antidote for Socialist nostrums is organization and efficiency. I believe this to be a better way than the erection of tariff walls or any other form of State interference. I believe, on the other hand, that with the great development of productive capacity which is bound to take place when peace has been restored in the world, it will be impossible for any combination of manufacturers to maintain prices at levels which will leave inordinate profits on cost of production.

SODIUM NITRATE AND SULPHURIC ACID.

We have had two striking examples during the past year of the Nemesis which overtakes a policy of extravagantly high prices. The Chilian nitrate producers, sitting in conclave 10,000 miles from their chief consuming markets, fixed a scale of prices in the summer of 1920 which was far above the capacity of consumers to pay. They sold a vast quantity at these high prices to a number of unfortunate merchants and speculators, who were ignorant about the possibilities of consumption. I cannot help feeling that if the Chilian producers had been in closer touch with actual consumers, the crisis which has caused fluctuations of over 50 p.ct. in the price of nitrogen, and has imperilled the very existence of the Chilean State, would never have occurred, because the attempt to force-up prices would never have been made. We have another example in what is happening in regard to sulphuric acid. Let me say that we greatly sympathize with acid makers—some of whom are members of this Federation—in their difficulties. We know that they have had to pay high wages, high costs of renewal, and high prices for their raw material. But, nevertheless, we feel that an attempt has been made to hold-up prices at a level which consumers cannot afford to pay. That attempt has failed; and I think acid makers are beginning to realize that just as the chemical industry of this country was unable to bear a price of £5 to £6 per ton last year, so now that industry cannot get on its feet again with acid at anything like £4 to £5 per ton. We believe that acid could be sold to-day at 60s. per ton without loss; and we must look to secure far more drastic reductions in the near future. The report indicates two directions in which it may be possible to move in order to secure that object.

IMPROVED QUALITY.

There need be no fear of loss of individual effort or incentive because we are members of a combine. Quite the contrary. In our own case there is a very healthy spirit of rivalry among the individual producers to improve the quality of their output. I think we can claim that, since the formation of a really effective central body for marketing the output of sulphate of ammonia here five years ago, greater progress has been made in the improvement of quality than during the twenty-five preceding years and more. This, I believe, to be due chiefly to the fact that we have brought home directly to the producer the needs of the consumer, and have given the maker first-hand information about the doings of our competitors.

INTERNATIONAL CONFERENCE.

We have further endeavoured to strengthen our position generally by our attempts to arrive at an understanding with our chief overseas competitors. The report I think shows clearly that we are under no extravagant illusions as to the immediate results to be expected from these attempts. We feel we must continue to rely primarily on our own powers of meeting competition and on our own propaganda work in order to secure our position. Nevertheless, we feel that it is right that an attempt should be made to understand the point of view of our competitors—both producers of sulphate of ammonia and other forms of nitrogen—and to see whether a measure of agreement cannot be attained which will at any rate help to increase the consumption of nitrogen as a whole; prevent speculation by middlemen, whose only object is to make a profit on the immediate deal; and to avoid those violent fluctuations in price which benefit nobody except speculators in the long run. These conferences have at least made it plain to the other groups that a fundamental change has taken place in the organization of British producers, and that producers of a bye-product are in a strong position if it comes to a fight. This brings me to my last point—a consideration of the future.

THE NITROGEN PROBLEM AND AGRICULTURE.

I think it is clear that the capacity for producing nitrogen in the world to-day is far in excess of the possibilities of immediate consumption. But I am sufficiently optimistic to believe that in the future the world will require all the nitrogen which can be produced in order to support an ever-increasing population and provide a higher standard of life. The rapidity of the increase in consumption will depend largely on the range and effectiveness of our propaganda efforts. Our national neglect of agriculture during the thirty years before the war has cost us many hundred millions of pounds; it came nigh to costing us victory itself in the war. Recent political events seem to point to the likelihood that agriculture will again become the Cinderella of national interests, in spite of the fulsome adulation bestowed upon her by politicians during the war. We must do our utmost to prevent this. We must seek out the individual farmer, and prove to him that it pays him to use nitrogen, and to use it in far larger quantities than he has dreamt of before. To do this we must show him that success can be achieved on a large scale and under conditions exactly similar to those under which he is working. That is why we attach so much importance to the arrangement, mentioned in the report, which we have made with the National Institute of Agricultural Botany. We are going to try and make the farm at St. Ives (and the other farms which we hope to work in the same way later) the envy of farmers near by and far away, so that they are stimulated to go and do likewise. I believe that envy will prove a more potent spur than Government exhortations, regulations, and leaflets. There are many who think the Government have made a grave mistake in repealing the Corn Production Act. There are others who feel that the giving of doles in any circumstances and in any form is wrong.

EXPORT CREDITS AND BRITISH FARMERS.

But I think it is permissible to point to a possible *via media* between these extremes. Our farmers have been very badly hit by the recent

fall in all agricultural produce. Many of them bought their farms at excessively high prices during the war and after, and, in consequence, are now in financial difficulties. They must perforce economize, and many of them say openly that they intend to economize by doing without fertilizers. That is false and disastrous economy; but you cannot force a man with no means to buy. What you can do is to deliver the fertilizers to him in return for part payment of the price, and let him pay the balance when he has sold his crop. Now with costs of production running as high as they are to-day, and with selling prices down to something like pre-war level, we manufacturers have no margin out of which to give credit to farmers. We feel that we have already made a very substantial contribution towards helping the farmer by reducing our prices so drastically. We wish to take due credit for the fact that we were the first among fertilizer producers to make a really substantial reduction in price. At our scale of prices for June to December, ranging from £13 3s. to £14 10s. delivered to British farmers, sulphate of ammonia has been by far the cheapest form of nitrogen available. But low prices are not much consolation to the man without cash. If, after proper investigation, it is found that farmers generally are really as hard hit as they lead us to believe, I wish to suggest that the Government might find it in the national interest to enable British fertilizer makers to give credit to the farmer at home in exactly the same way as the Government are helping exporters. If we liked to go to the Government to-day with a scheme for selling sulphate of ammonia to Polish or Rumanian farmers, we could get a guarantee against loss to practically the full extent of our risk. Why should the Poles and the Rumanians receive this preference, given at the risk of the British taxpayer, if the British farmer is in a precarious position? By giving the British farmer credit, the Government would be assisting our most important national industry at a critical moment, and at the same time doing something to lessen the annual tribute which we pay to the United States for vast quantities of foodstuffs. In view of the decision that we are to commence paying interest on our American debts next year, surely it is to the interest of the Government and the taxpayer to do everything possible to reduce the premium at which the dollar stands compared with the pound.

TOTAL STOCKS LIQUIDATED.

As to future prices, while we cannot (and I think I may say ought not to) look for a return to anything like the level of price which we obtained last year, we see no reason at present why we should not be able to maintain our present position. Our general position is vastly improved compared with what it was at the end of May, for our drastic reductions in price have enabled us to liquidate the whole of our stocks; and at the same time we have orders on our books for a substantial portion of our future production. In conclusion, therefore, I wish to say that I feel that the Federation has fulfilled the hopes and expectations of its founders during a year of exceptional difficulty, and that we can face calmly and steadfastly whatever the future has in store for us, if we can continue to count on your support and that of all our other members. [Applause.]

GENERAL BUSINESS.

The report* and accounts having been unanimously approved and adopted, on the motion of Sir ARTHUR PEASE, Bart., seconded by ALDERMAN W. KAY (*ex*-Lord Mayor of Manchester), both of whom spoke in complimentary terms of the work of the Chairman and the Executive Committee, Mr. D. Milne Watson was re-elected Chairman.

Mr. E. J. George (Consett Iron Company, Ltd.) and Mr. A. K. M'Cosh (Wm. Baird & Co., Ltd.) were unanimously re-elected Vice-Chairmen. The Auditors (Messrs. Thomson, M'Lintock, & Co.) having been re-appointed, a hearty vote of thanks was accorded to the Chairman, Vice-Chairman, Executive Committee, and the staff for the services rendered to the Federation during the year.

* See "JOURNAL" last week, pp. 572–3.

DARLINGTON GAS-WORKS ACCOUNTS.

The accounts and statistics of the Borough of Darlington Gas Department for the year ended March 31 (prepared by Mr. A. E. Ruffhead, the Engineer and Manager, and Mr. G. Dobson Wright, Borough Accountant) show a gross profit of £6769, and a small net loss of £1667, which has been transferred to the reserve account. For the previous twelve months, there was a net profit of £4908.

The price of gas was reduced from 3s. 1d. to 2s. 9d. per 1000 c.ft. in October, 1920, to give the consumers the benefit of the increased price received for residuals; and the department set out to make only sufficient gross profit to cover interest and liquidation charges. For the quarter ended March 31 last, however, the revenue from tar and ammoniacal liquor, was greatly below the estimate; and the relaying of a 12-in. feeder main proved more costly than anticipated. Otherwise, there would have been a net profit of about £300.

In spite of the fact that the sale of gas for power purposes, which is subject to special discount, was 10,000,000 c.ft. below the previous year, the average price of gas for the year ended March last was only 3s., against 3s. 2½d. for the previous twelve months, and 2s. 1½d. per 1000 c.ft. for the year ended March, 1914. The total quantity of gas sold last year was 523,682,000 c.ft., and the proportion unaccounted for was 4·95 p.ct. The amount of coal carbonized was 39,017 tons. The make of gas per ton of coal was 14,292 c.ft., as compared with 14,153 c.ft. in the preceding year.

Churnet Valley Gas Company, Ltd.—In their report for the year ended Sept. 30, the Directors state that the revenue account shows a profit of £816; and adding the amount brought forward and deducting interest charges, there is a disposable balance of £1062. The payment of a dividend of 5 p.ct. will leave £362 to be carried to the next account.

GAS COMPANIES AND CO-PARTNERSHIP.

The lately-issued twenty-fifth annual report of the Labour Co-Partnership Association, in giving the customary table of statistics regarding gas companies' co-partnership and profit-sharing schemes, and some details of the arrangements in different cases, says:

The co-partnership gas companies are still very seriously and adversely affected by conditions arising from the war—notably, of course, the very high price of coal. The result is that nearly all the schemes have, in one way or another, become inoperative, chiefly by the price of gas being far higher than the point at which any dividend on wages becomes payable. Some companies have made temporary changes to enable some dividend on wages to be paid; others, considering the present condition permanent, have altered the standard figures; others, again, thinking that a scheme should be flexible enough to meet all conditions—even those so abnormal as are consequent on war—have made changes which bring a share of profits to labour as soon as capital receives any interest at all. The South Metropolitan Gas Company's Act of 1920 is most important, in that it is the first instance of profit-sharing being confirmed in an Act of Parliament as a legal right of the workers. We give the usual table of financial results for the gas companies; but we cannot guarantee that some bonuses or gifts have not been included in the more orthodox "share of profits" predetermined by a scheme. It must, however, be borne in mind that co-partnership includes not only the sharing of profits, but also the holding of capital and the sharing in control either through ownership of share capital or the existence of a Co-Partnership Committee. These latter remain alive, even when the absence of profits prevents any dividend on wages being paid; and, of course, the right to share in profits is untouched, and will become active as soon as normal conditions of trade return.

Particulars at Dec. 31, 1920, of British Gas Companies who have adopted Co-Partnership and Profit-Sharing.

Name of Company.	Number of Years Scheme has been in Operation.	Capital in 1920. Total Share and Loan.	Number of Employees under Agreement for Profit-Sharing or Co-Partnership.	Amount Divided among Employees for Year ending December, 1920.	Amount Per Cent. on Wages.	Total Profit to Employees since Scheme was Adopted.	Amount of Shares and Deposits held by Employees in the Company. Market Value on Dec. 31, 1920.
South Metropolitan (*a*)	31	9,255,350	9,200	Nil	Nil	771,804	355,640
South Suburban (*a*)	27	1,609,184	1,322	3,024	¾	70,790	50,934
Commercial	19½	2,548,280	1,282	4,113*	3	96,100	71,628
Tunbridge Wells	12½	185,266	137	Nil	—	5,674	3,522
Bournemouth	12	945,000	388	2,397	4	27,424	18,951
Walker and Wallsend	12	262,728	95	352*	3·5	4,170	3,483
Wellingborough	12	90,853	86	185	1·4	3,927	2,506
Tottenham (*c*)	12	1,948,705	541	Nil*	Nil	39,347	34,430
Croydon (*d*)	12	861,586	719	3,230	4	27,526	19,485
Weston-super-Mare	12	186,213	77	Nil	Nil	2,276	845
Gas Light and Coke	12	29,455,018	9,720	41,877*	3	373,073	223,292
Grantham	12	106,068	67	278	2·6	2,893	1,788
Watford	12	227,000	187	1,019	3	6,166	6,245
Wandsworth	11	1,302,295	936	Nil	Nil	27,676	22,226
Harrow	10	333,956	84	532	3	3,565	1,750
Liverpool	9½	3,049,124	1,770	1,273	¼	63,166	43,879
Hertford	9	22,609	26	140	3	708	609
Redhill	7½	196,886	59	187*	2	1,103	630
Ipswich	7	193,865	165	277	1	2,692	2,046
Totals	—	52,779,986	26,861	58,884	—	1,530,080	863,889

* To June, 1920.

(*a*) Three employee representatives on the Board.
(*b*) Period of eighteen months to December, 1920.
(*c*) Company made gift of £1611 to employees, being two-thirds contributions to Pension Fund.
(*d*) To March, 1920.
(*e*) From last year.

Notes: Dartford has amalgamated with the South Suburban.
Suspended: Cambridge, Merthyr Tydfil, Swansea, Ilford.
Ceased: Wrexham, Maidenhead, Plymouth, Cardiff.
No information: Waterford, Chester, Leamington, Rugby, Gloucester Longwood, Aldershot, Canterbury, Shrewsbury.

ELECTRICITY IN GAS-WORKS.

In the course of a paper at the Public Works Congress at the Agricultural Hall on Friday last, Mr. S. J. WATSON, the Borough Electrical Engineer of Bury (Lancs.), said that although many electrical engineers staunchly refuse to acknowledge that gas can be used as successfully as electricity for most purposes, and many gas engineers declare with emphasis that electricity is a "wash-out," there is no doubt that the true instincts of the trained engineer to adopt the particular form of prime mover most suitable for the specific purpose required will assert itself in the long run. It was not, therefore, surprising to find that the public supply of electricity is being used to an increasing extent in a direction hardly contemplated when it was originated. The fact should also be mentioned that in 26 of the towns from which the particulars given in the paper were obtained, the supply of gas is in the hands of private companies. In such cases there doubtless exists a tendency for the company-owned gas undertaking and the municipally-owned electricity works to remain entirely independent of one another. Where both the gas and electricity works are owned and operated by the local authority, there is a greater willingness to co-operate to mutual advantage.

In 33 gas-works owned by local authorities there are at present in

use 296 motors, having an aggregate horse-power of 4620, and an annual consumption of 1,918,525 units. These motors are used in connection with machinery for charging and discharging retorts, gas compressors and boosters, coal and coke crushing and conveying elevators, the mechanical stoking of boilers, telpher runways, ventilation, high-pressure compressors, machine tools, &c.

DISCUSSION.

Mr. F. M. LONG (City Electrical Engineer, Norwich) said a good deal of electrical power was being used at the Norwich Gas-Works. This was remarkable, because the gas-works did not belong to the Corporation. They had in the city a very up-to-date gas engineer and manager, who was a man of broad views; and he had for many years driven his plant by means of electric motors. Up to recently he had generated the power himself by means of gas-engines. Now that the works had been almost entirely rebuilt, however, and there was not much room to spare, the gas manager asked the electricity department to give him a supply—partly to save capital expenditure and partly on account of lack of space. This was very much to the credit of Mr. Glover. The speaker thought not every gas manager would go to the electricity works for his power supply. Mr. Glover and himself were on very good terms; and in a small way the electricity department took some gas. He did not believe in the electricity and gas people keeping at arm's length. They could be very good competitors, and at the same time very good friends. The consumption of electricity by the Gas Company was about 40,000 units a year.

Mr. ALLSOPP (Sales Manager, Bradford) said that the gas-works took about 250 H.P. from the Corporation electricity works; and it was a gratification to know that it was obtained without any pressure from the department.

Mr. WATSON, replying to the discussion, read a letter which he had received from Mr. Fedden, of Sheffield, in which some information was given as to the development there. At the Sheffield Gas-Works there was 407 H.P. of direct current and 54 H.P. of alternating current motors. A further scheme involving the use of 19 motors, with a total of 242 H.P., was in progress in connection with the installation of vertical retorts.

GAS SUPPLY IN MID-LANARK.

Progress continues to be made by the Committee on Gas Supply of the District Committee of the Middle Ward of Lanarkshire in linking-up the various gas-works of that industrial area and in the adoption of the Burghs Gas Supply Act in the respective villages or supply districts of the Ward.

At a meeting of the District Committee on Friday last, minutes were submitted showing the progress made with various schemes already under the Gas Committee's management, such as Bellshill and Mossend, Bothwell and Uddingston, Cambuslang, and Larkhall. One other area is making application to the authorities for a better supply—namely, Carfin, which is on the outskirts of the burgh of Motherwell. A letter was received from the Town Clerk of Motherwell and Wishaw to the effect that their Gas Engineer reported that the demand for gas in the Carfin area was now at a stage when the plant there was no longer able to cope with it, and that immediate action was therefore necessary. A conference with the District Committee was suggested; and a deputation from the burghs which are at present supplying the area was in attendance at the Gas Committee's meeting. Provost Frood stated that the Town Council were desirous of ascertaining whether the District Committee proposed in the near future to take over that portion of the gas undertaking in the county formerly belonging to the Carfin, Newarthill, Cleland, and District Gas Company, as the supply of gas in the district was not adequate to the needs of the area, and that it would be inadvisable for the Town Council to undertake any extensions if any proposal at the instance of the District Committee for dealing with the area were in immediate contemplation. The Burgh Gas Manager stated that the present condition could be remedied if a 10-in. low-pressure main (estimated to cost about £3000) were laid from Motherwell to Carfin Cross. The Town Council would not be disposed to undertake this work if, by so doing, their position under their statutory provisions would be in any way prejudiced. The result of the deputation's interview was that the Gas Supply Committee of the Middle Ward agreed that their Clerk (Mr. W. E Whyte) should confer with their Consulting Engineer (Mr. Doig Gibb) on the whole situation, and afterwards report.

It appears the gas supply in the Dykehead and Shotts district was also under consideration; and a report by Mr. Doig Gibb showed that Shotts (which is at present served by the Stane and Dykehead Gas Company) would ultimately be served by the line of main—Uddingston, Bellshill, Holytown, Carfin, and Shotts. The coming winter would see the Uddingston to Bellshill section finished. He gave details of the costs of mains and makes of gas, and said that Shotts was not such a good commercial proposition as other places nearer the source of supply. Step by step a high-pressure main would be laid towards Shotts; but he could not even suggest that it would reach there in 1922. He advised that the present time was not opportune to take formal steps for the acquisition of the Shotts undertaking. In a further statement, Mr. Doig Gibb said the existing plant at Uddingston would not be able to serve the district right up to Shotts.

A deputation from a public meeting was afterwards heard on the subject of the exorbitant price and inadequate supply of gas in the district, and asking the District Committee at the earliest possible moment to become the undertakers for the supply in the area. They suggested in particular that the Committee should come to an arrangement with the Gas Company whereby new mains could be laid, which would ultimately be embraced in the Middle Ward scheme. This, in their opinion, would effect a great improvement. The Committee decided that the Clerk should confer with Mr. Doig Gibb on this suggestion, and report.

It was reported that the County Council had confirmed the District Committee's resolution with respect to the adoption of the Burghs Gas Supply (Scotland) Act, 1876, within the Blantyre area. It was agreed that certain informal inquiries should now be made of the Blantyre Gas Company and the Holytown Gas Light Company with reference to the acquisition of their respective undertakings.

The District Committee adopted the minutes.

UNVEILING OF THE BIRMINGHAM WAR MEMORIAL.

With impressive ceremony, the beautiful permanent war memorial which the staff and employees of the Birmingham Gas Department have raised to their colleagues who fell in the war was unveiled last Saturday week. The memorial has been erected in the hall of the head office in Edmund Street; and memorial tablets will be placed at each of the works of the department. The whole of the cost is being defrayed by members of the Gas Committee, the staff, and the employees.

The memorial is designed in cenotaph form, crowned with a figure of Britannia, holding in one hand a little Niké or Victory alighting on a globe, and in the other, emblems (the bay and the fir) of the valour and steadfastness of her sons. The coat-of-arms of the city they served is attached to the cenotaph, upon which the names of the fallen are incised in gold, and the message to this and future generations is inscribed at the foot: "Let those who come after see to it that their names be not forgotten." During the erection of the memorial, a cavity was formed, into which was placed a complete roll of the 1239 men from the department who joined H.M. forces. The artist was Mr. W. Gilbert, of Birmingham.

The company was large and thoroughly representative of the various departments. There was a full attendance of members of the Gas Committee, and Alderman J. H. Lloyd (the Chairman) was accompanied to the front of the cenotaph by the Lord Mayor (Alderman David Davis), and Town Clerk (Mr. Wiltshire).

Alderman Lloyd said they were assembled, as a great department of the Birmingham Corporation—workmen, staff, members of the Gas Committee, and relatives of the deceased men—unitedly to commemorate their comrades who fell in the war. They met with mingled feelings—many of them under a great sense of personal loss; but they all rejoiced in the courageous part those who answered the call of King and country were able to take. Of the employees in the Gas Department, 1239 joined the forces, and 156, or 12½ p.ct. of those who served, lost their lives. At the end of the war the staff and workpeople of the department met together and decided to erect a central memorial at the Council House, and tablets at each of the works, in memory of their fallen comrades; and also to set up a Welfare Fund to render help from time to time to all dependants of those killed in the war or who died on active service. An appeal was made for contributions from all sections of the department; and about £1200 was raised, of which £200 had already been expended in relieving necessitous cases. He thought they would all agree that the fund reflected great credit on the staff and workpeople of the department. After the immediate necessities of the bereaved, a thought was given to the provision of a further memorial; and this led to the erection of the one then to be unveiled. It had been bought by all connected with the Gas Department, as an expression of deep gratitude to their brave comrades.

Mr. R. G. Warr, who was selected from the ex-service men of the department, by ballot, then unveiled the memorial.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Nov. 28.*

In the London tar products market there is rather more demand for pitch; and there is a distinctly firmer tone. Makers call the quotation to-day from 57s. 6d. to 60s. per ton. Creosote is steady at about 7½d. to 8d. per gallon. Pure benzole and pure toluole are about 3s. 6d. per gallon; 95 160 solvent naphtha being from 3s. 3d. to 3s. 6d. per gallon. Pyridine bases is 5s. 6d. to 5s. 9d. per gallon. In other products there is nothing new to report.

Tar Products in the Provinces

Nov. 28.

The average values for gas-works products during last week were: Gas-works coal tar, 42s. 6d. to 46s. 6d. Pitch, East Coast, 45s. to 47s. 6d; West Coast—Manchester, 40s. to 45s.; Liverpool, 40s. to 45s; Clyde, 40s. to 45s. Benzole 90 p.ct. North, 2s. 4d. to 2s. 6d.; crude 65 p.ct. at 120° C., 1s. 11d. to 2s. naked at makers' works; 50-90 p.ct., naked, North, 2s. 3d. to 2s. 4d. Toluole, naked, North, 3s. to 3s. 1½d. nominal. Coal tar crude naphtha in bulk, North, 11d. to 11½d. Solvent naphtha, naked, North, 2s. 8d. to 2s. 9d. Heavy naphtha, North, 2s. 7d. to 2s. 9d. Creosote, in bulk, North, liquid, 6½d. to 7d.; salty, 6½d. to 6¾d. Heavy oils, in bulk, North, 10½d. to 11½d. Carbolic acid, 60 p.ct., 1s. 6d. Naphthalene, £15 to £20; salts, £7 to £9, bags included. Anthracene, "A" quality, 8d. to 10d. per minimum 40 p.ct.; "B" quality, nominal.

FROM A MARKET CORRESPONDENT.

Bye-Products Trade.

There is very little fresh to report in the market for tar products. Outputs generally are not very great at the moment, and apparently there is no immediate prospect of an increase by a return to activity on the part of coke-ovens. This stagnation keeps prices of most products from falling-away. Pitch is weak and decidedly irregular. It is difficult to get any exact prices. Quotations, however, range from 40s. to 47s. per ton; and even at these prices there is very little con-

fidence in the market. Solvent naphthas keep firm on a better inquiry; the latest values being 2s. 9d. to 2s. 11d. per gallon. Naphthalenes are without change; but there is a better demand for crude material from the firelighter trade, and values are £6 to £8 10s. per ton. Refined makes are from £14 10s. to £18 per ton. Creosote remains dull, with a downward tendency. The price is about 7d. per gallon, which is not bad considering the current value of mineral fuel oil. Benzole is comparatively scarce, with quotations firm, although any advance is checked by the prices of petrol. Pure benzole is 3s. 8d. per gallon on rail. Cresylic acid is fairly steady without change of quotations; but there is no change in carbolic acid, and at present values very few makers take the trouble to extract it. The nominal price of crude 60's is 1s. 6d. per gallon; but makers of crystals want to buy it under 1s. 3d., in order to sell crystals at a profit. The value of crystals is about 5½d. to 6d. per lb. Business in intermediate products continues quiet, with prices somewhat in buyers' favour. There has been rather more inquiry, however, for export. Aniline oil and salt are a little better at 1s. 8d. to 1s. 9d. per lb. respectively, and resorcin is also better at 5s. 6d. to 6s. per lb. for technical grade. Beta naphthol is 2s. 6d., and salicylic acid, technical grade, 1s. 3d. per lb.

Sulphate of Ammonia.

The market remains steady without any change of price. Export prices range from about £16 10s. to £17 per ton on a fairly good demand, particularly from Spain, France, and Belgium, and Far Eastern Ports. The French Sulphate of Ammonia Bureau have fixed prices for December, January, February, and March at 95 frs. per 100 kilos for ordinary quality and 100 frs. for extra dry material. The French production, as before stated, is insufficient for the requirements of the country; and the balance will have to be met by imports, which will be taken from Great Britain for the most part. German sulphate of ammonia is quoted at 92·50 frs. per 100 kilos on rail at the French frontier.

TRADE NOTES.

[For "Journal" Advertisers.]

Lead Wool for Jointing.

It is now fourteen years since lead wool for jointing was first introduced into this country by the Lead Wool Company, Ltd., of Snodland, Kent; and it has been used for all kinds of work under widely varying conditions. The method of manufacturing, the manner of packing, the tools for use, and the best ways of using lead wool, have all been carefully studied, in order to produce uniformly excellent results with the greatest economy; and the results of these investigations will be found concisely set out in the latest illustrated catalogue of the Company. It is claimed that the lead-wool joint is twice as strong as the ordinary run-lead joint, and that it will withstand without leakage three times the vibration and sagging, because it is caulked throughout. At the same time, the cost is approximately one-third less. To use the material, no special skill is required, and no more than average strength. The requirements for the work do not include a cumbersome melting apparatus, but merely a small set of tools which the Company supply. There can also be obtained from the Company petrol-driven portable compressors for testing mains, and machines for the pneumatic caulking of lead-wool joints. Their metallic packings are of various kinds, according to the purposes to which it is intended to put them.

A Large Oil-Fuel Tank Contract.

The Whessoe Foundry and Engineering Company, Ltd., have been recently favoured by the Admiralty with a contract for the supply and erection in Singapore of ten steel oil-fuel tanks, each 116 ft. diameter by 45 ft. 6 in. deep. These tanks will be capable of holding about 12,000 tons of oil each—probably a greater capacity in one unit than any oil-storage tanks hitherto erected.

Water Gas and Its Auxiliaries.

Among the firms who are finding it more advantageous to issue their catalogues in sections are Messrs. R. & J. Dempster, Ltd., of Manchester, who recently issued a Condenser and Gasholder Section, and now forward another dealing with Water Gas and Its Auxiliaries. In this latter, the "Manchester" total carbonization plant (Knight and Siddall's patent) occupies first place; and a general view is given of a plant having a capacity of 300,000 c.ft. per day, designed to produce a mixed gas having a calorific value of from 400 to 450 B.Th.U. Not only is the plant self-contained, but it occupies an exceptionally small ground space for the output and quality of gas which can be produced, and labour charges are very small. By means of the plant sufficient coke can be obtained for supplying other parts of the works if desired; and by the intermixing of the water gas with the coal gas full advantage is taken of the gravity of water gas in picking-up the light hydrocarbons from the coal gas. If necessary blue water gas alone may be produced. The plant can be in full operation, and producing a 400 B.Th.U. gas within a few hours after being first lit-up. Particulars are also given of the Dempster-Dellwik water-gas process, and other types of water-gas plant. The production of hydrogen gas is fully dealt with; and there is a section devoted to the application of water gas to welding, &c.

Cheaper Gas at Brighton.—An announcement by the Brighton and Hove General Gas Company that, from the end of the present quarter, 4¾d. per 1000 c.ft. will be taken off the existing charge for gas, makes a total reduction of over 7d. per 1000 c.ft. since September last. "The Directors," say a local paper, "deserve every credit for the public-spirited policy that has marked their actions for many months past."

Simmance Patent

DEAD BEAT PRESSURE RECORDERS

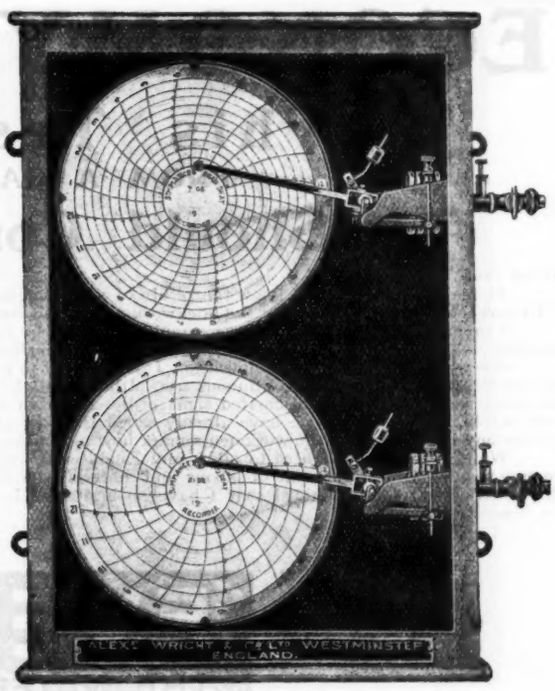
In BATTERIES of
Any number
Any range of
Pressure or Vacuum.

No Liquids.

Instant Zero adjustment.

Pressure released by turning cock.

Oscillations Obviated.



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Instructing Meter Readers.

The Rochester (N.Y.) Railway and Light Company, it is explained by Mr. L. A. Newman, have improved upon their original method of imparting instruction with regard to their duties to new men employed as meter readers. The plan formerly was for this instruction to be given by a man of some years' experience. The "pupils" were usually taken out on the district by the instructor, who endeavoured to teach them as he completed his own day's work. This proved to be both slow and a source of trouble for the man, as some applicants were quicker than others in picking-up their new line of work. Another disadvantage was that the meter reader is paid a commission or a bonus for the amount of meters read in a day. Thus the time spent at each meter in instructing the new man was a loss to him, and lessened his bonus. A board was therefore provided upon which was mounted a gas and electric dial of each type of meter commonly used by the company. The applicant is now instructed by the supervisor in the meter reading department, who can devote more time to each individual, and therefore save the outside man the preliminary instruction which was formerly necessary at each meter. The applicant is then given one or two days outside with an experienced meter reader for practice before being allowed to go out alone.

A Reduction at Sunderland.—The Sunderland Gas Company announces a reduction of 3d. per 1000 c.ft. in the price of gas supplied by them, to take effect after the next quarterly readings. The new price will be 3s. 9d. per 1000 c.ft. for lighting, heating, and cooking, and 3s. 7d. for power purposes, less the usual discounts.

Forthcoming Reduction in Liverpool.—After the December quarter readings, there is to be a reduction in price by the Liverpool Gas Company. The concession, which applies particularly to consumers through ordinary meters, will reduce the price to 11d. per therm, equal to 4s. 4¾d. per 1000 c.ft. In addition, notice is given that the discount to be allowed to consumers through prepayment meters will be so increased as to permit of a net charge of 12·5d. per therm, to take effect upon collections made after Dec. 31.

Mainlaying at Teignmouth.—A start is to be made with the relaying of gas-mains at Teignmouth, which will employ many of the hundred odd unemployed in the town. At a special meeting of the Urban Council, it was reported that the Ministry of Health forwarded sanctions to loans in connection with plant for the Gas Department as follows: Exhauster, £480; condensers and erection, £541; gas-mains, £3500. It was moved by Mr. F. H. Rogers that, before proceeding further in regard to the loans for the condenser and exhauster, Mr. H. Higham (the Gas Manager) should ascertain the present-day price as compared with the price when the tenders were submitted in February. An amendment was moved that the Clerk be authorized to accept an offer to arrange for the loan at 6½ p.ct.; and this was ultimately carried. It was also decided that the work of laying the mains be carried out departmentally.

Dunfermline Gas Department.—The estimated revenue of the Dunfermline Gas Department for 1921-22 is £61,671, and the expenditure £61,515; bringing out an estimated deficit for the year of £155. Tar and sulphate of ammonia showed a large drop in values.

Commercial Gas Company's Reduction.—The Directors of the Commercial Gas Company have sent out a notice intimating that the price of gas will be reduced from 1s. 3d. to 1s. 1d. per therm as from the reading of the meters for the Christmas quarter. This reduction is equal to 9½d. per 1000 c.ft.

Gas-Mains and Housing at Darlington.—The Darlington Gas Committee have considered the extension of mains for the supply of gas to houses being built at Cockerton under the housing scheme. There are 200 houses; and it was estimated that to connect-up these with the gas supply would involve an expenditure of £6000, or £30 per house. This would incur a heavy loss; and the Committee decided to refuse to lay mains unless the Government gave a reasonable guarantee respecting the outlay. The Committee were of opinion that the cost should be treated as part of the housing expenditure.

Gas Profits at Keighley.—The financial report of the Keighley Corporation Gas Department, issued last week, shows a gross profit for the year ended June 30 of £7323, increased to £7472 by bank interest, and a net profit of £1898, after deducting for sinking fund, &c. The net profit is added to by £2258, balance brought forward from last year, and by £1662 from the working capital account, making a total of £5820 disposable. This figure being the estimated cost of public lighting, the Gas Committee recommend its transference to the relief of the district rate, and that £100 be granted to the local hospital.

The Gas Industry and Applied Chemistry.—This was the title of a paper read before the members of the Chemical Society at the Cardiff Technical College by Mr. H. D. Madden, M.Inst.C.E., the Chief Engineer of the Cardiff Gas Company. Mr. Madden drew attention to the incalculable value of the bye-products derivable from soft or high volatile coals, and the urgent need for the prevention of the wasteful use of a precious and diminishing national asset. He said he was a believer in the policy that only steam coal, coke, and anthracite, or those forms of fuel containing practically no volatile matter, should be used for direct heating purposes. The consumption of soft coal for direct heating was akin to breaking-up the household furniture to feed the fireplace, only worse, because the furniture could be replaced, but never the coal measures. Coals containing volatile constituents should be carefully treated and the valuable products sorted-out and utilized in their own particular spheres by constructive distillation. For this reason he considered the gas-works practice and coke-ovens to be the proper method for the utilization of coal, and therefore a field of immense interest to chemists. He commented with warm approval on the campaign of the South Wales Institute of Engineers, and their recent exhibition of patents to increase the efficiency of coal-consuming appliances, such as boilers, in an urgent endeavour to conserve the nation's supply of coal.

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DEAR SIRS, *1st April*, 1921.

It may interest you to know the result of your suggestion that we should coat the front of our retort benches with "Everok" for the preservation of the brickwork and at the same time the conservation of heat.

I might first mention that we were unable to carry out your suggestion to apply the "Everok" by means of a spraying machine as such was not available and consequently had no alternative but to apply the "Everok" with an ordinary hand brush.

Even with this superficial application I am pleased to inform you that the brickwork shows absolutely no deterioration whatever after nine months' continuous use, although in the ordinary course of events (due to our unfortunate method of working) we should have anticipated signs of deterioration within two months. The preservation of the brickwork is so remarkable that I estimate we have already saved the cost of material and labour many times over apart from the question of economy in fuel. Even the workmen remark how nice and cool it is in front of the bench treated with "Everok."

Whilst I shall be delighted to allow any Engineer to inspect the Retort Bench in question and obtain any information he may require, I think the cost of labour and materials necessary to coat an ordinary retort bench so small compared with the remarkable results obtained that I have no hesitation in recommending every Gas Engineer to make the experiment for himself.

Yours faithfully,
Name on application.

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Is a colourless solution on the "NO-VOID" principle for rendering the surface of EXISTING CEMENT, CONCRETE, STUCCO, BRICK, STONE, &c., impervious to water or the destructive action of nature.

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Congratulations at Oswaldtwistle.—Mr. Hargreaves informed the Oswaldtwistle Urban District Council last week that it had been found possible to reduce the price of gas by 6d. per 1000 c.ft. to ordinary meter users, making the net price 3s. 9d., from the quarter ending December. He thought the Gas Manager (Mr. J. H. Davies) and staff ought to be congratulated on such a reduction, considering the township had only a population of 15,000. There were only six townships in the country which could show a better result. Mr. Usher said, as a matter of fact, there were only three townships with cheaper gas.

Unemployment and Gas and Coke Prices.—The following resolution has been passed by the Devonport branch of the National Union of General Workers, and submitted to the Town Clerk and the Chairman of the Gas Committee: "We desire to call attention to the fact that the price of coal and labour has been considerably reduced; but the price of gas to the consumer still remains the same. Further, the price of broken coke is the same as coal. Bearing in mind the great mass of unemployed, the reduction in wages all round, and the position these items occupy in the list of a working man's weekly expenses—especially at this time of the year—we consider that steps should be taken to reduce the price of these commodities."

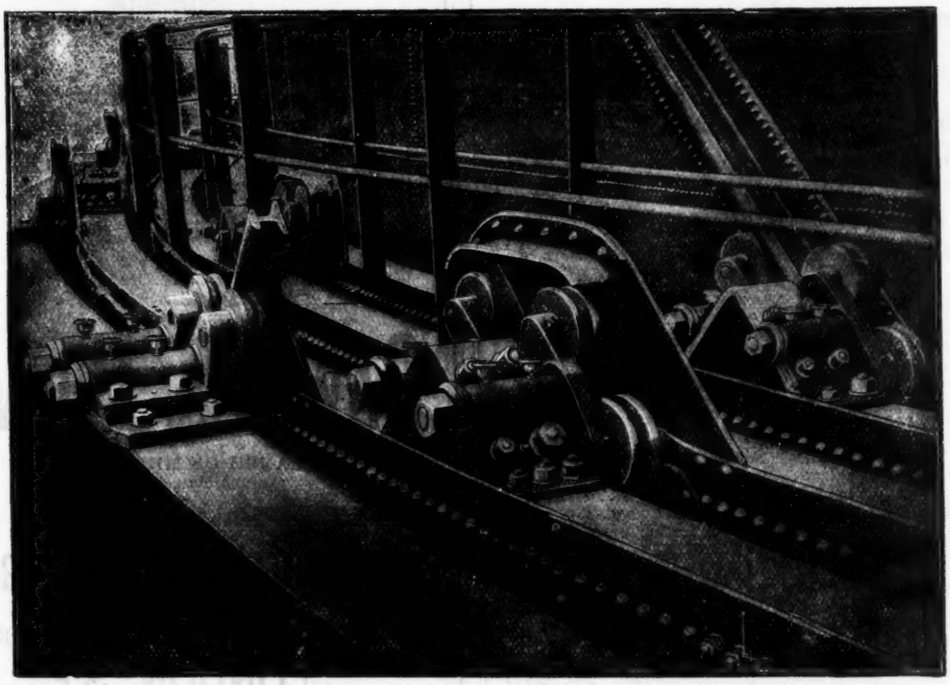
Derby Gas Charges Revised.—The Derby Gas Company announce that, from the December reading of meters, the price of gas will be charged in accordance with the following revised scale: For lighting, cooking, and heating purposes—if the consumption be under 100,000 c.ft. per quarter, 10d. per therm; districts outside Derby, 10$\frac{3}{4}$d. per therm, and no discount; for 100,000 c.ft. and under 500,000 c.ft., a discount of 2$\frac{1}{2}$ p.ct.; 500,000 c.ft. and under 1,000,000 c.ft. per quarter, discount 5 p.ct.; 1,000,000 c.ft. and under 2,000,000 c.ft. per quarter, discount 7$\frac{1}{2}$ p.ct.; 2,000,000 c.ft. and upwards per quarter, 10 p.ct. discount. The public are reminded that 10d. per therm equals 4s. per 1000 c.ft. for 480 B.Th.U. gas. For motive power and manufacturing purposes, if registered by separate meter, the charges are lower.

Lighting the Embankments and Bridges.—Mr. J. D. Gilbert, M.P., asked, at a recent meeting of the London County Council, what was the system of lighting for the Victoria and Albert Embankments and Westminster and Waterloo Bridges; whether the lighting was let out to contract, and what was the approximate yearly cost for each embankment and bridge; and if it was not possible to have the same system of lighting for all the Council's bridges and embankments. Mr. W. J. Squires (the Chairman of the Highways Committee) replied that the Victoria Embankment and Westminster Bridge were illuminated by incandescent electric light; and the Albert Embankment and Waterloo Bridge, by incandescent gas light. The yearly cost was: Victoria Embankment, £4230; Westminster Bridge, £900; Albert Embankment, £347; Waterloo Bridge, £480. The adoption of the same system of lighting for all the Council's bridges and embankments would involve a large initial expenditure, for which there did not appear to be any justification.

Primitiva Gas Company of Buenos Ayres.—Last Monday week, Mr. F. C. Norton presided at an adjourned general meeting of holders of first debentures of the Primitiva Gas Company of Buenos Ayres, called to consider an agreement with the Ueberseeische Elektricitats, for consent to the taking over of the assets and liabilities of the German Company by a Spanish Company called the Compania Hispano Americana de Electricidad. Sir A. Bowen said the Board had given the matter careful consideration, and had come to the conclusion that there was no cause for objection. They had, however, stipulated for an increase in the half-yearly payments as the consideration for giving their consent to the assignment. The Spanish Company had agreed to increase the half-yearly payments by £1250, which would be a distinct advantage to the debenture holders. Careful investigation had been made by the Board as to the legal and financial position of the Spanish Company. The resolutions were agreed to.

Colonial Gas Association, Ltd.—The report for the year ended June 30, which was presented at yesterday's meeting of the Association, stated that, though there have been further labour troubles, the general conditions in Australia are now gradually becoming more normal. After deducting £2862 for depreciation, increasing the renewals fund from £9810 to £10,330, and adding £6318 brought forward from the previous year, the amount available for final dividend on the preference shares, and for the year's dividend on the ordinary shares, was £19,346. The preference dividend (less tax) to June 30 was duly paid, and reduced this amount to £17,751, out of which the Directors recommended payment of a dividend on the ordinary shares of 8 p.ct. (less tax), adding £1000 to the reserve fund account, and carrying forward the sum of £6445. Additional debentures to the amount of £25,000 have been issued. Further capital is, however, urgently needed to meet the requirements of the undertaking for new works and plants; and the Directors decided to invite the shareholders to subscribe for redeemable debenture bonds, bearing interest at the rate of 8$\frac{1}{2}$ p.ct. per annum, less tax.

Bristol Gas to be Cheaper.—The Directors of the Bristol Gas Company have decided to reduce the price of gas 4d. per 1000 c.ft., to take effect after the reading of the meters for the December quarter. The revised price will be 4s. 2d. for the March quarter. The present charge of 4s. 6d. came into operation in July, 1920, since which date there have been several increases in the cost of coal and labour; but a further advance in the price of gas was avoided owing to the enhanced value of residuals during that period. The Company were in a position to maintain a full supply of gas during the recent national coal strike, and did not increase their charges, despite the fact that the extra cost of accumulating ample stocks and supplementing coal supplies by purchasing foreign coals at abnormal prices amounted to upwards of £25,000. Since the termination of the strike, the value of residuals—particularly tar and ammonia products—has been very seriously reduced, and has largely neutralized the effect of recent reductions in the cost of coal and labour. The dividend of the Company is limited to 5 p.ct. per annum.



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MANCHESTER.

Moore's Gas Generator Syndicate.—A Company having this title has been registered with a capital of £21,000 in 10,000 10 p.ct. cumulative preference, 10,000 ordinary shares of £1 each, and 20,000 founders' shares of 1s. each, to carry on the business of manufacturers of, and dealers in, generators or any apparatus for the manufacture, generation, or supply of gas, &c. The registered office is at No. 88, Bishopsgate, London, E.C.

Thefts from Gas-Meters at New Cross.—At Greenwich Police Court, before Mr. Disney, Charles Mitchell, of Brocklehurst Street, New Cross, was charged with stealing money belonging to the South Metropolitan Gas Company from three houses in the same street. At the police station, after he had denied the charge, prisoner said: "I will tell you the truth, and I am willing to face it. It was me that took the money from the meters; I had to get some money to pay the rent. It is betting that has done this." Prisoner was committed to prison for three months, with hard labour.

Cost of Repairs at Aberystwyth.—At a recent meeting of the Aberystwyth Town Council, a report on the Gas Company's balance-sheet for the half year was presented by Alderman Roberts. He pointed out that a sum of £2678, equal to 7½ p.ct. on the total capital of the Company, had been charged against revenue in respect of maintenance of plant. This appeared as if the Company were making consumers provide capital, and not payment for gas consumed. The Town Clerk was directed to write to the Company and ask for an explanation. The Company's reply, which was read at last week's meeting, stated the money had been used for repairing the plant, which they could not do during the war, and the cost of which to-day was 200 p.ct. above pre-war rates. The Company hoped to make a reduction in the price of gas (now 5s. 10d. per 1000 c.ft.) in the near future. Alderman Roberts said this did not answer the point raised in his report. He asked for an assurance from the Company that the money was not being used for capital expenditure. It was decided to ask the Company for a further explanation.

Athens was in darkness and without communications last week, owing to a strike of electricians, gas workers, and tramwaymen.

The annual smoking concert and distribution of cricket and bowls prizes in connection with the Richmond Gas Works Athletic Club took place at the Orange Tree Hotel, Kew Road, Richmond, last Thursday. The large room was filled to its utmost capacity with members and friends; and the chair was occupied by the President of the Club, Mr. E. George Hutchinson (the Engineer and General Manager of the Company), who was supported by Dr. G. H. Rodman (Director), Mr. F. Green (Assistant Engineer), Mr. Lewis Smith, Mr. H. Glenie, Mr. A. Stevens (Vice-President), and Mr. T. J. Clark (Hon. Secretary). In the course of the proceedings, the formation of a Works Committee was suggested; and Mr. Hutchinson said he was in sympathy with the idea, which he hoped would materialize.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Nov. 23.]

Nos. 30,266 to 30,995.

BACHHOFER, P.—"Gasifying liquid fuel." No. 30,754.
BELLAMY, R. F.—"Locating fluid leakage faults in underground conduits." No. 30,525.
BERGSUNDS MEKANISKA VERKSTADS AKTIEBOLAG.—"Multiple-way valves, cocks, &c." No. 30,763.
BERGSUNDS MEKANISKA VERKSTADS AKTIEBOLAG.—"Valves, &c., for fluids." No. 30,764.
BOLTON, C. F.—See Bellamy. No. 30,525.
DOWSON & MASON GAS PLANT CO., LTD.—"Gas-producers." No. 30,941.
DUGON, A. L.—"Recording pressure gauges, indicators, &c." No. 30,768.
DÜLL, R.—"Cooling coke." No. 30,647.
FALL, G.—"Portable crown plate for gas-cookers." No. 30,413.
FOX, T.—"Dry gas-meters." No. 30,693.
FRICKER, E. H.—"Means for mounting atmospheric gas-burners in gas-fires, gas-cookers, &c." No. 30,779.
GRESSWELL, H.—"Flow-meters." No. 30,700.
HEWISON, W.—"Treatment of tar, &c." No. 30,995.
LODGE FUME COMPANY, LTD.—"Method for working electrical gas-purifiers." No. 30,461.
LODGE FUME COMPANY, LTD.—"Separating suspended particles from gases, &c." No. 30,625.
MATTOCK, W. G. H.—"Gas-lamps." No. 30,868.
METALLBANK UND METALLURGISCHE GES.—See Lodge. No. 30,461.
METHERINGHAM, J. T.—"Devices for connecting pipes to mains under pressure." No. 30,622.
MÖLLER, E.—See Lodge. No. 30,625.
MÜLLER, J.—See Bachhofer, No. 30,754.
NUTMAN, H. H.—"Gas-stoves." No. 30,703.
OGDEN, W.—"Machines for simultaneously discharging and charging gas-retorts, ovens, &c." No. 30,798.
QUAIN, J. R.—"Electric gas-lighter." No. 30,702.
RECTOR, E.—"Production of gaseous combustible fuel." No. 30,732.
ROBINSON, S.—See Fox. No. 30,693.
SAVONIUS, S. J.—"Geyser." No. 30,847.
SHADBOLT, S. M.—"Valves, &c." No. 30,407.
SHEPPARD, H. B.—"Loading wagons, &c., with coal, coke, &c." No. 30,894.
SHILLETO, A. W.—"Gas-rings for cooking, &c." No. 30,958.
SOUTH METROPOLITAN GAS COMPANY.—See Metheringham. No. 30,622.
SUGG & CO., LTD.—See Mattock. No. 30,868.
TEISEN, T.—"Gas-heated furnaces." No. 30,605.
WILSON, E.—"Gas-producers." No. 30,941.
WOODHEAD, C. J.—See Ogden. No. 30,798.

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Mr. T. B. Walker, representative for South Wales and the West of England, of Messrs. Gibbons Bros., Ltd., and Gibbons (Dudley), Ltd., has removed from Cardiff to No. 20, Cotham Park, Bristol.

At the works of the Harrogate Gas Company, a coal stack of some 5000 tons has been on fire during the past fortnight. After a week's work, it was thought to be extinguished, but it broke out again. The coal is stored in bunkers under an extensive roof. The firemen, wearing gas-masks, can work only in comparatively short spells individually, owing to the fumes from the coking of the coal.

Arrangements for the Welsh National Exhibition, which is to be held at Cardiff from May to October next year, and of which the Prime Minister is President, are well in hand. A substantial guarantee fund is being prepared, and is being liberally supported. The work on the exhibition is commencing forthwith, under the direction of Sir Charles T. Ruthen, the President of the Society of Architects. It is anticipated that the exhibition will be ready for opening on May 1.

Through the generosity of the Chairman and Directors of the Cardiff Gas Company, one of the finest sports pavilions in the district has been erected on the Company Athletic and Social Club's ground at Grangetown. The building was opened on Saturday last, in the presence of a large company, by Mr. George Clarry, the General Manager and Secretary of the Company, who pointed out that the Directors fully realized the value of social intercourse among members of their staff, and had always been ready to meet the wishes of their workmen in providing the necessary means of recreation. Mr. R. G. Shute, on behalf of the employees, thanked the Chairman and Directors and the officials for their magnificent gift. Mr. Clarry afterwards kicked-off in a Rugby football match between the work's fifteen and a local team. When completed, the sports ground will be one of the best equipped in South Wales. There has already been provided a winter tennis court, and work is proceeding on a summer tennis court, croquet lawn, bowling green, cricket pitch, and Badminton courts. The membership of the club is over 700.

STOCK MARKET REPORT.

THERE was no change last week in the general run of things on the Stock Exchange—business continuing quiet, with a dull tendency; but the close was not the worst of the week.

The gilt-edged division fluctuated. In Home Government issues, the big four closed unchanged—viz., Consols 48⅞-49¼, War Loan 87⅛-88⅛, Funding 72⅞-73¼, Victory 79⅛-79¾. Bonds were fairly steady, and Colonial issues firm. Home Rails were irregular, and Argentinas were similar; but Canadians improved.

Business in the Gas Market was quite active; Gas Light and Imperial Continental again being the cynosures of attraction, with South Metropolitan a good third. The tone was very firm, especially in the home undertakings. Further advances in quotation were made by Gas Lights, Commercials, Brentfords, Brighton and Hoves, Ilford, South Suburban, Lea Bridge, Newcastle, and Sheffields. In the Continentals, both issues of Union advanced in response to the dividend prospect; but Imperial had a setback of 7 points on the non-realization of expectations from Germany. Primitivas were hardly touched at all.

Bargains done for cash during the week were as follows: On Monday, Continental Union 19, Croydon "A" 155, 157, ditto "B" and "C" 122½, 123, Gas Light ordinary 63⅜, 63⅞, 64, 64¼, Imperial Continental 145, 146, 147, 148, 148½, 149, 150, 151, 152, ditto debenture 84, Oriental 87, Primitiva 13s., South Metropolitan 69½, 69¾, 70⅜, South Suburban debenture 74, Tottenham "B" 54⅛, 54⅜, ditto 7½ p.ct. debentures 102⅞, 103⅛, Wandsworth New 57½. On Tuesday, Aldershot preference 51½, 52, Brentford "A" 70, Continental Union preference 34, Gas Light ordinary 64, 64⅛, 64⅜, 64½, ditto maximum 44⅜, 45, ditto preference 60½, 61, 61½, ditto debenture 52, Ilford "B" 62½, 62¾, Imperial Continental 138, 140, 140½, 141, 143, 144, ditto debenture 84, 85, Primitiva 12s., 12s. 9d., ditto preference 37s. 6d., Sheffield "B" 63, ditto "C" 63, South Metropolitan 69¾, 70, 70¼, ditto 6½ p.ct. debenture 103, 103⅜, Wandsworth new 58, Ottoman 7 p.ct. preference 30s., 31s. On Wednesday, Alliance and Dublin 49⅜, Bombay 3, 3 1/16, 3⅛, Brentford preference 70, 70½, British 22⅞, 23, 23⅛, Commercial 4 p.ct. 56, Continental Union 20, Gas Light ordinary 63¾, 64, 64⅛, 64⅜, 64⅝, ditto maximum 45, 45⅛, ditto debenture 51½, 51⅝, 52, Imperial Continental 139, 140, 140½, 140⅝, 141, 141½, 142, ditto debenture 84, 84¼, 84⅜, 84¾, 84⅝, Liverpool 64⅜, Oriental 86½, 87, San Paulo debenture 36, South Metropolitan 69½, 69¾, 70½, ditto 6½ p.ct. debenture 103, 103¼. On Thursday, Bombay 3⅛, Brighton and Hove original 117, Commercial 4 p.ct. 56, 57, ditto 3½ p.ct. 52½, 53, Continental Union 20, European 6⅝, Gas Light ordinary 64, 64⅛, 64½, 64⅝, 64⅝, ditto maximum 45, 45¼, 45⅛, 45⅜, 46, 46¼, 46½, ditto debenture 51⅜, 51⅝, Imperial Continental 140, 140⅜, 141, 142, ditto debenture 84⅜, Newcastle 64, ditto debenture 51, 51½, Oriental 87½, Primitiva 12s., South Metropolitan 70½, ditto 6½ p.ct. debenture 103, Lea Bridge 7½ p.ct. debenture 102, 102½, Uxbridge and Wycombe 5 p.ct. 51, 51½, Para 5 p.ct. debenture 48. On Friday, Gas Light ordinary 64⅛, 64¼, 64⅜, 64⅝, 64¾, 64⅞, 65, ditto maximum 46¼, 46⅜, 46½, ditto preference 61½, 61⅜, 61⅞, ditto debenture 52, Hornsey 103, Imperial Continental 139, 140½, 141, Newcastle 64, Primitiva 12s. 6d., South Metropolitan 70, South Suburban debenture 75⅛.

In the Money Market, the general conditions continued to rule very firm, and supplies were by no means over-abundant. However, it was rather easier by the close. Silver had a fall to 37⅝d. The Bank rate is 5 p.ct., as fixed on Nov. 3.

ANTE-WAR PRICES AND DIVIDENDS, LATEST DIVIDENDS, AND LAST WEEK'S BARGAINS.

Issues.	Share.	When ex-Dividend.	Ante-War Dividend & Bonus.	Last Dividend.	NAME.	Closing Prices, July 30, 1914.	Present Prices.	Lowest and Highest Prices of Bargains.
£			p.c.					
182,049	Stk.	Aug. 26	4	4%	Aldershot 4 p.c. Pref.	...	50—55	51½—52
1,551,868	,,	Oct. 13	2½	3 1/13%	Alliance & Dublin Ord.	59—64	48—51	49⅜
374,000	,,	July 14	4	4%	Do. 4 p.c. Deb.	76—79	46—51	
280,000	5	Aug. 11	7½	4/-	Bombay, Ltd.	5⅜—6⅜	3—3⅜	3—3⅛
100,000	5	,,	16	4/7½	Bournemouth Gas and Water { 5 p.c. B 7 p.c. Pref. 6 p.c. 4 p.c. Deb.	...	7⅛—8⅛	...
383,110	10	,,	7	7/-		15—15½	8½—9⅜	
115,000	10	,,	6	6/-		13½—14	7½—8⅛	...
162,065	—	June 30	—	4%		...	54—59	...
992,045	Stk.	July 15	14	56/-	Brentford A Consolid.	261—266	69—72	70
734,920	,,	,,	11	55/-	Do. B New	204—209	69—72	...
55,000	,,	,,	5	5%	Do. 5 p.c. Pref.	109—111	68—72	70—70½
221,400	,,	June 15	4	4%	Do. 4 p.c. Deb.	91—95	57—50	...
214,775	,,	Aug. 26	11	10%	Brighton & Hove Orig.	208—213	117—122	117
244,200	,,	,,	8	7½%	Do. A Ord. Stk.	154—159	84—89	...
1,287,500	Stk.	July 28	5	5%	Bristol 5 p.c. max.	...	...	...
530,000	20	Sept. 29	13½	10%	British	44—45	22—24	22½—23½
120,000	Stk.	June 30	4	4%	Do. 4 p.c. Deb. Stk.	88—90	55—58	...
245,771	,,	,,	4	4%	Buenos Aires 4 p.c. Deb.	85—87	42—45	...
100,000	10	May 27	—	6%	Cape Town & Dis., Ltd.	1½—2½	6½—7½	...
100,000	10	Oct. 28	—	4½%	Do. 4½ p.c. Pref.	4—6	4½—5½	...
100,000	Stk.	June 30	4½	4½%	Do. 4½ p.c. Deb. Stk.	70—75	53—58	...
137,150	,,	Feb. 26	5	5%	Chester 5 p.c. Ord.	108—110	...	...
1,513,880	,,	July 28	5/9/4	42/8	Commercial 4 p.c. Stk.	106—108	55—60	56—57
560,000	,,	,,	5½	38/4	Do. 3½ p.c. do.	103—105	52—57	52½—53
475,000	,,	June 15	5	5%	Do. 3 p.c. Deb. Stk.	69½—71½	44—47	...
100,000	,,	Dec. 11	4	—	Continental Union Ltd.	76—79	19—21	19—20
200,000	,,	,,	7	—	Do. 7 p.c. Pref.	115—118	35—40	34
51,600	,,	Aug. 26	15	15%	Croydon A 10 p.c.	...	150—155	155—157
278,400	—	,,	12	12%	Croydon B and C 7 p.c.	...	120—125	122½—123
492,370	Stk.	—	6	4½%	Derby Con. Stk.	123—125	...	...
55,000	,,	—	4	4%	Do. Deb. Stk.	102—104	...	...
1,002,180	10	Jan. 29	10	5/0	Buropean, Ltd.	17½—18	6½—7	6⅝
16,398,075	Stk.	Aug. 11	4/17/4	46/8	Gas Light & Coke { 4 p.c. Ord. 3½ p.c. max. 4 p.c. Con. Pref. 3 p.c. Con. Deb. 10 p.c. Bonds.	9⅜—10⅜	6⅜—6⅝	6⅜—6⅝
3,600,000	,,	,,	3½	35/-		76—79	45—48	44⅜—46⅛
4,062,335	,,	,,	4	4%		96—99	60—62	60⅜—61⅛
4,674,850	,,	June 15	3	3%		72½—74½	51—53	51½—52
130,000	,,	Dec. 11	10	10%		...	...	...
82,500	,,	Sept. 14	5	3½%	Hastings & St. L. 5 p.c.	...	48—50	...
258,740	,,	,,	3½	2½%	Do. 3½ p.c.	87—89	38—40	...
70,000	10	May 12	11	5%	Hongkong & China, Ltd.	16½—16¾	5—6	...
86,600	Stk.	Aug. 26	9	9½%	Hornsey 7 p.c.	...	100—105	103
131,000	,,	July 28	7½	7½%	Ilford A and C	151—154	84—86	...
65,780	,,	,,	6½	5½%	Do. B	115—118	61—63	62½—62¾
65,500	,,	June 30	4	4%	Do. 4 p.c. Deb.	92—94	57—59	...
1,976,000	,,	Oct. 28	9	5%	Imperial Continental	150—160	138—143	138—152
1,235,000	,,	Aug. 11	3½	3½%	Do. 3½ p.c. Deb. Red.	84—86	83—85	84—85
255,242	,,	Mar. 30	6½	3½%	Lea Bridge Ord. 5 p.c.	119—121	72—74	...
2,498,905	,,	Feb. 26	10	37/6	Liverpool 5 p.c. Ord. { A. B.	211—215 / 146—148	...	64⅛
306,083	,,	June 26	4	4%	Do. 4 p.c. Pr. Deb. Stk.	...	...	...
165,756	,,	Aug. 11	7/3/6	6%	Maidstone 5 p.c.	...	54—56	...
63,480	,,	Dec. 30	—	3%	Do. 3 p.c. Deb.	...	40—43	...
75,000	5	June 11	6	5%	Malta & Mediterranean	4½—4⅝	2—2½	...
250,000	100	Oct. 3	4½	4½%	Met. of Melbourne 4½ p.c. Deb.	99—101	88—96	...
541,920	Stk.	May 27	4	6%	Monte Video, Ltd.	11½—12	55—60	...
1,875,892	,,	July 28	4½	3%	Newcastle & Gatsh'd Con.	98½—99½	63—65	64
529,705	,,	June 30	3½	3½%	Do. 3½ p.c. Deb.	82—83	51—52	51—51½
13,000	10	Aug. 26	—	7/6	North Middlesex 10 p.c.	...	12½—13½	...
55,940	10	,,	7/14/0	5/3	,, ,, 7 p.c.	14—15	7½—8½	...
500,000	Stk.	May 12	8	8%	Oriental, Ltd.	117—122	85—90	86½—87½
60,000	5	Mar. 26	10	1/-	Ottoman, Ltd.	7½—7¾	2—3	...
188,120	Stk.	June 30	—	3½%	Plym'th & Stonch'se 5 p.c.	...	64—67	...
60,000	50	Aug. 26	15	60/-	Portsea Island, B	128—131	64—67	...
100,000	50	,,	12	55/-	Do. C	118—121	52—54	...
249,980	5	April 29	8	—	Primitiva Ord.	5½—6	⅛—¼	12/—12/-
499,960	5	June 26	5	—	Do. 5 p.c. Pref.	4½—5	1 1/16—2 1/16	37/6
521,600	100	June 1	4	4%	Do. 4 p.c. Deb.	91—93	25—67	...
600,000	Stk.	July 28	4	4%	Do. ,, ,, 1911	...	42—45	...
346,198	,,	June 30	4	4%	River Plate 4 p.c. Deb.	8½—87	42—45	...
150,000	10	Sept. 29	6	6/-	San Paulo { 6 p.c. Pref. 5 p.c. Deb.	10½—11	6—6½	...
125,000	50	June 30	5	5%		47—49	35—38	36
135,000	Stk.	Aug. 26	10	5%	Sheffield A	223—224	62—64	63
209,984	,,	,,	10	5%	Do. B	222—224	62—64	...
523,500	,,	,,	10	4½%	Do. C	220—222	62—64	63
133,201	Stk.	Sept. 15	4	4%	Shrewsbury 5 p.c.	...	...	...
90,000	10	Oct. 28	9	8%	South African	10½—11½	7—9	...
6,609,895	Stk.	July 28	5/4/0	5%	South Met. Ord.	111—113	69—72	69½—70½
250,000	,,	July 14	—	5%	Do. Red. Pref.	...	93—95	...
1,895,445	,,	,,	3	3%	Do. 3 p.c. Deb.	72½—74½	48—50	...
224,820	,,	Feb. 25	8½	7½%	South Shields Con. Stk.	157—159	88—90	...
1,087,795	,,	Aug. 11	6	5½%	S'th Suburb'n Ord. 5 p.c.	114—116	69—71	...
368,837	,,	June 30	5	5%	Do. 5 p.c. Deb. Stk.	116—118	73—76	74—75½
647,740	,,	Nov. 16	7½	4%	Southampton Ord.	99—102	54—57*	...
121,875	,,	June 30	4	4%	Do. 4 p.c. Deb. Stk.	...	59—61	...
120,000	,,	Aug. 11	—	6%	Tottenham { A 5 p.c. B 3½ p.c. 4 p.c. Deb.	155—158	63—65	...
782,375	,,	,,	6	4½%		115—117	53—55	54½—54¾
181,255	,,	June 15	4	4%		87—89	54—57	...
182,380	10	Dec. 30	5	—	Tuscan, Ltd.	5—6	1—2	...
149,900	10	July 1	5	5%	Do. 5 p.c. Deb. Red.	93—95	45—50	...
256,476	Stk.	Aug. 26	5	3½%	Tynemouth 5 p.c. max.	103½—109	64—66	...
					Wandsworth, Wimbledon, and Epsom—			
30,000	,,	Aug. 11	8½	66/3	Wandsworth A 5 p.c.	151—156	78—80	...
253,636	,,	,,	6½	51/3	Do. B 3½ p.c.	129—134	59—61	...
108,075	,,	,,	—	46/4½	Do. C	...	36—38	...
140,865	,,	,,	—	46/4½	New Ordinary	...	57—59	57½—58
552,000	,,	,,	6½	45/-	Wimbledon 5 p.c.	117—122	53—55	...
98,000	,,	,,	6½	50/-	Epsom 5 p.c.	122—126	56—58	...
88,416	..	June 30	5	3½%	5 p.c. Deb. Stk.	66—69	44—47	...

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